HIV/AIDS, risk and intertemporal choice

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PROEFSCHRIFT

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"Your work is to discover your work and then with all your hart give yourself to it"

-Buddha-

This thesis is based on a collection of four studies, which I wrote together with four different co-authors to which all I am very grateful. In order of the chapters of this dissertation:

"*The HIV Anticipatory Savings Motive: An Empirical Study in South Africa*"
CentER Discussion Paper No. 2007-51.
(joint work with Dr. G. van de Kuilen)

"*HIV Contamination Risk, Savings and the Welfare Effects of Diagnostic Testing*"
CentER Discussion Paper No. 2007-50.
(joint work with Prof. Dr. A.C. Meijdam & Prof. Dr. H.A.A. Verbon)

"*HIV/AIDS and Individual Preferences over Risk and Time: A Laboratory Experiment in South Africa*" *Mimeo.*
(joint work with Dr. M.I. Lau & Prof. Dr. H.A.A. Verbon)

"*HIV/AIDS, Risk Aversion, and Intertemporal Choice*"
Tinbergen Institute Discussion Paper, TI 2007-098/1.
(joint work with Prof. Dr. S.J.G. van Wijnbergen)

Preface

Although I started my PhD studying a different topic, the current topic had caught my interest many years before. I got acquainted with HIV/AIDS when the world was jolted awake by The Freddie Mercury Tribute Concert for AIDS Awareness, which was organized shortly after Freddy Mercury's death in November 1991. The lyrics of Queens' famous song *"The show must go on"* can be construed to be a reflection on life and imminent death. But it was especially the effort of Freddie Mercury continuing to perform despite approaching the end of his life that inspired me. I got intrigued by how people manage in difficult situations, such as imminent morbidity and mortality. And I was fascinated by how they managed to just go on.

It was many years later that I was confronted with HIV issues more closely, during my stay in Mozambique. For my Master's thesis on a new Bayesian national accounts estimation system I was collecting data at the national institute of statistics (INE). While reading the UNDP National Development Reports for Mozambique during lunchtime, I came across the astonishing high number of HIV infection rates and the assumed implications these numbers would have for Mozambique's economy and society as a whole. However, I was surprised by

the lack of a dataset that included both health and economic statistics, which would be needed for a correct measurement of the *actual* impact on both individual and country level.

I also remember the day I got tested for malaria at Maputo's health center, where I found myself in a conversation with a young girl of my age who received a positive test during our talk. Her non-reaction to this test result shocked me more than the test result itself. It made me question what influence this disease actually has for people in developing countries. Did she really understand the consequences of her disease? Or is being infected in such a country less important or shocking than in western society because of all the other difficulties and risks they are already facing in daily life?

One day during the same internship I came across the convention of putting private savings to zero in the national accounts in developing countries. I was astonished and believed this was an unreasonable assumption regarding the fact that even in the shacks I had visited households had a fridge and television, consumer goods that are impossible to buy out-of-pocket or from their monthly income. Thus, these households must have saved somehow.

The internship in Mozambique offered me the opportunity to work closely together with a world expert in national accounting, Jan van Tongeren, and he made me enthusiastic to use the skills I had learned during my study in econometrics for analyzing issues in developing countries. I was fortunate that Jan Magnus stimulated me to stay in the academic world and enabled me to continue working on the further development of this Bayesian estimation system for the national accounts as part of a PhD.

However, after a while I felt that I actually wanted to work *with* the data instead of working on the development of a system that *delivers* better data and enables others to study developing issues. This made me radically change my research topic and after one and a half year of research, I started afresh. The questions raised by the three experiences described above soon became the ingredients for the main question of this dissertation. Do households adapt their economic behaviour such as their saving behavior to the HIV/AIDS health shock? Hans Moors stimulated me in changing my field of research to one that was fully in line with my interests and compassions. My choice was also both intrinsically and financially supported by Harry Huizinga who was the director of the CentER Graduate School at that time. Lex Meijdam and Harrie Verbon were willing to guide me in a topic that was not yet

theirs, which I admire because it is not at all easy to supervise someone who had already decided what she wanted to do. I really appreciate the confidence and opportunity that they all gave me to start all over again, and was happy to have discovered the work to which I could easily dedicate three full years of my life.

I started with the simple lifecycle model of Chapter 4. However, soon I discovered that with the available data, I could not even test this simple model, neither analyzing the other ideas I had in mind. Together with Harrie Verbon and Morten Lau, we therefore decided to design a survey that next to questions covering socio-economic, financial and health characteristics also included experiments from which we could elicit risk and time preferences and we choose South Africa as country to conduct the survey.

The incurable illness of close family soon put a different face upon my research. This disease had a similar uncertain course like HIV/AIDS: One can live your whole life having only few symptoms, but also a short life and in severe illness. How to deal with a disease that may change your physical health in the nearby but maybe only in the far future? The economic impact of a positive diagnosis is large; for example risk of loosing your job, stigmatization, and increased cost of life. Being incurably ill requires making choices from a new often smaller set of possibilities under additional constraints.

However, there are not only negative aspects of being incurably ill. It puts a different view on life. Many try to enjoy life as much as possible, but not in the "carpe-diem way". Contrary to what some people might think; many people start making investments one would otherwise not have done so, like additional saving, studying, etc. In one of the many talks I had with several HIV coordinators of the different universities I visited in South Africa, I was told that student's study results improved after a positive diagnosis. Marchal Kender, I really hope to research this further together with you in the near future. In a one-to-one interview after one of the experiments a student told me *"I have more future now then without HIV"*. Also K. and G., two students who helped me in organizing the experimental sessions, showed this strength, positivism and an extreme willingness to go on. These councilors and students did not only help me with the actual organization but gave me insight in the influence of HIV on decision making in life and above all they inspired me to continue my research. This places the title of the famous paper of Alwyn Young in which he estimates a positive impact of HIV on

economic growth *"The gift of the dying"* in a totally different perspective: Looking forward and going on.

The contrasts, however, are large and I cannot let some of my heartrending experiences unmentioned. Different countries, different people, and different stages of illness; while paying a visit to the AIDS department of the St. Joseph Helen's hospital in Jo'burg, I was terrified by the severeness and consequences of the disease: waiting rooms full of people surrealistically holding their medical report in different colors indicating their stage of illness. Terminal AIDS patients in the open rooms around showed them what was looming ahead. A man was falling down to the ground without being picked up, simply because the nurses were too occupied with all those other waiting patients. Due to lack of space, consults even took place in the same already way too crowded waiting room... The planned experiments at the University of the Witwatersrand could not take place, because two of the HIV support group members were taken to the intensive care. Besides, in the same week, there had again been violence against gay and HIV infected people, so that they could not allow strangers in their group. Of course, also the visit to the local VCT center and the AIDS orphanage on the outskirts of Potchefstroom hit me, where in one week time two little children had had a heart attack because of emotional stress.

The sadness and seriousness of the problem I took home, having difficulties to see these people as data points in my dataset, but also the necessity for more research and therefore the urgency to continue. All these experiences made the topic real and research difficult and made me wonder how all these infected persons managed just to go on. From Marten van Garderen and Martine Smits I received enormous help in the organization of respectively the first and second round of experiments, but also on the spot and back home they were indispensable as sounding board. Their voluntary assistance was of inestimable value.

After the completion of this dissertation, I am still amazed by the commitment to life of people in such difficult situations, only now I have proof that they do reconsider the remaining options and adapt their economic choices limiting the huge impact as much as possible. Still my work is not finished, new questions arose, and some were not answered. Therefore, I am happy that the Amsterdam Institute for International Development (AIID), in particular Jacques van der Gaag, offered me the opportunity to continue my research in a project that will at least answer some of them. Also for me the show must go on!

Acknowledgments

Next to the other wonderful persons I already mentioned in the preface, there are many more colleagues, friends and family to which I owe words of gratitude: Looking back on the sometimes long journey to the completion of this work, Tilburg University was a fantastic place to conduct this PhD. This was mainly due to the kindness and helpfulness of my colleagues from both the Econometric and Economics Department. Thank you all for offering me this inspiring environment. I was certainly blessed to have Anne Gielen as my officemate. We shared much more than only scientific issues. Thank you for the thousands of conversations we had and the positive atmosphere in our office. It made Tilburg University a place which I went to each day with a lot of pleasure for three years at a stretch. Same applies to Johannes and Yvonne. All three of them were always there for me, and became next to colleagues above all good friends.

This dissertation benefited a lot from many discussions, seminars, and conferences. Next to my co-authors, in particular Hans Binswanger, Rene Bonnel, Jan Boone, Jeffrey James, Katherine Carman, and Norma Coe provided me with useful advice and comments to this work. My favorite chapter (Chapter 7) was born from the valuable comments I received during the workshop on the Economics of HIV/AIDS organized by the AIID in 2006.

Collecting your own data in a country such as South Africa requires a lot of support from the people there and here. This dissertation would have had a completely different content without the generous financial support of the Netherlands Organization for Scientific Research (NWO), and CentER. Thank you colleagues from North West University, Center for the Study of AIDS (Pretoria University), University of Johannesburg, and University of the Witwatersrand, in particular Prof. S.N. Mashego, Prof. W.A. Naude, Neo Mabille, Elana Olivier, Jason Wessenaar, Teolene Diedericks, and Marchal Kender for your hospitality, discussions and help in the organization of the different surveys. Thank you also Peter and Faten for the wonderful time you gave me during my stay for the second round of experiments. Above all, many words of gratitude I, of course, owe to all the participants in the survey, especially to the members of the HIV support groups. I appreciate the trust they showed in allowing me and Martine to conduct the experiments during their gatherings. Back in Tilburg the secretaries, Marja, Nicole, Corina and Ella helped me with entering the data for 213 students and Marta Serra Garcia assisted me in the processing of the data. Thank you.

Mariska Tijmstra, Judith Scheijmans, Marten van Garderen and my sister provided a bridge between practice and the scientific world and helped me to stay focused and not to lose sight of the goals I had in mind when starting my PhD.

Dear parents, family, relatives and friends. How much I appreciate your patience… Among those not yet mentioned; Belinda, Janneke, Lotte, Maaike, and Nadia. How could you all respect my choice to devote three years to this work and to give up a large part of our personal life. Thank you for understanding the need for me to do so. Janneke Verber deserves a special place in this row, as she listened on the phone almost everyday to both my endless research enthusiasm and struggles. Most grateful I am to my ballet teacher and good friend Len Staals, for her unconditional support in every decision I made in life. She taught me to accept things that cannot be changed, but also how to find the positivism and strength to accomplish the many things that *are* possible, this work being one of them.

I would like to end my words of gratitude with thanking my supportive promoter Lex Meijdam for his guidance and keeping me focused during the whole process. I also owe countless thanks to Sweder van Wijnbergen, who also guided, helped and advised me especially in the final year of my dissertation. Your support is of inestimable value. Thank you both very much!

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Chapter 1

Outline and Motivation

1.1 Introduction

This dissertation studies the impact of the HIV/AIDS[1] pandemic from an economic perspective. It in particular discusses the effect on intertemporal choice in Southern Africa, i.e. it studies how the pandemic changes how and what choices individuals make over time, including both economic choices, such as saving decisions, and choices of risky sexual behavior.

After its discovery in the late 1970s, HIV, the virus that causes AIDS, started to afflict the African continent, and rapidly developed to a widespread catastrophe. By 2005, over 25 million people have already died of AIDS related diseases, while 39.5 million people are living with HIV worldwide. High levels of HIV prevalence rates are concentrated in Southern Africa with 18.8% in South Africa in 2005 (UNAIDS, 2006). Especially in Southern Africa, HIV/AIDS, originally a health-problem, is expected to cause large changes in society as a whole. The projected erosion of some of the main determinants of economic growth such as social capital, domestic savings, and human capital caused by the epidemic, will damage both

[1] HIV, AIDS are acronyms for respectively Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome

social and economic development. Although the social impact appears to be devastating, the economic literature is divided on the impact on economic growth.

A possible explanation for the ambiguous effects on economic growth might be that behavioral changes take place at the micro level, mitigating the negative effects on an aggregate level. Although many impact studies have been written on the HIV/AIDS epidemic and economic growth, little attention has been given to the indirect behavioral effects, such as the effects on intertemporal choices including saving decisions, which is the central topic of this dissertation.

1.2 Motivation

An epidemic like HIV/AIDS could change intertemporal choices in various ways. Although extensive literature discusses how intertemporal choice is changed by either health, health risk or by demographic changes, the literature encompassing all three of them is relatively limited. In view of the fact that HIV/AIDS is related to all three aspects, the overall effect of HIV/AIDS on intertemporal choices is still undefined. Obtaining insight into individuals' economic decisions is, however, important in understanding the coping strategies of households and the consequences of the epidemic for economic growth.

Complicating factor is that different groups in society will respond differently to the epidemic. As HIV/AIDS is a slow-moving disease, the impact on HIV affected and AIDS affected households[2] differs. For instance, savings of *AIDS* affected households is reduced by an increase in expenses, like medical treatment and care, aggravated by a decrease in income due to lower productivity or loss of job. On the other hand, the increased health *risk* may stimulate cautiousness of both *HIV* affected and *not (yet)* affected households and as a result raise savings. The total impact on aggregate savings depends thus on the size and effect of each group.

Furthermore, demographic changes like a sharp increase in the uncertainty of human life (rising mortality rates, or falling life expectancy) modify consumption patterns by making saving for old-age consumption less necessary. On the other hand, households may become

[2] An HIV or AIDS affected household in the most limited definition is a household that respectively consists of at least one HIV infected or AIDS-sick member. In the broadest definition every household in the hardest hit countries are affected since the far-reaching consequences of the disease in society. This dissertation uses the most limited definition.

more prudent when the dependency ratio increases, knowing that the tax base is eroded, since HIV strikes an unequal share of prime-aged adults.

Moreover, the extent to which consumption behavior is influenced depends on individual risk and time preferences, which at the same time may be associated with perceptions of HIV contamination risk or HIV status. Inasmuch as HIV is mainly contracted through own risky behavior, possibly related to preferences for the present, the impact on the level of savings is likely to vary across households classified by both risk attitudes and time preferences. The existing literature however, lacks any opinion on this matter. Finally, risky sexual behavior is a type of "consumption" with consequences later in life, and is therefore an intertemporal choice in itself. Knowledge about this particular consumption choice is relevant for prohibiting HIV spreading further.

In summary, at the micro level intertemporal choices in societies with high HIV prevalence rates are influenced in many ways, such that the overall effect is ambiguous. Two important characteristics of HIV result in opposing forces on savings: Mortality increases, which reduces savings. However, long-term illness risk increases, which increases savings. Although the first effect is generally accepted in the current literature on the economics of HIV/AIDS, the second effect is not yet recognized however important in understanding both prevention and coping strategies of households and the consequences for economic growth. Therefore the second effect is particularly object of study in this dissertation.

1.3 Outline

This dissertation is a first attempt to simultaneously study the different channels through which the HIV/AIDS epidemic in Southern Africa influences intertemporal choices. In particular, illness risk, mortality and risk and time preferences. In this way, it adds to a better understanding in how societies respond to health shocks having the scale of HIV/AIDS.

The thesis is written so that each chapter can be read independently. Given that the themes treated in the different chapters are very much related to each other, the reader will find some back and forward references in the different chapters. Moreover, the reader of the whole dissertation will find some overlap between the chapters. This manuscript roughly consists of three parts indicated in Table 1.1.

Table 1.1: Thesis outline

Part	Chapter	Method	Level
I	2	Empirics	Macro
	3	Empirics, Literature & Theory	Macro & Micro
II	4	Empirics & Theory	Micro
	5	Theory	Macro & Micro
III	6	Experiments	Micro
	7	Theory & Experiments	Micro

Part I (Chapter 2 and 3) is a general introduction to the topic. Chapter 2 summarizes some general facts on the disease that are relevant for the following chapters. It presents HIV incidence and prevalence figures and describes the demographic impact for the hardest hit countries.

Subsequently, Chapter 3 provides background information on the different channels through which HIV/AIDS influences intertemporal choice and vice versa. Without having the ambition to give a complete overview, the chapter briefly discusses the current literature on impact studies of HIV/AIDS on economic growth and the existing literature that deals with health shocks, health risk, and demographic changes separately. In addition, it discusses the relations between risk and time preferences and health, mortality and sexual behavior, and touches upon the limited number of experimental studies that analyzed these relations.

Part II models the impact of HIV/AIDS on saving behavior. Chapter 4 in particular tests whether individuals consider both the reduction in expected lifetime, the risk of contracting the virus and its economic consequences when deciding on how much they save. The chapter theoretically derives the relation between saving behavior, mortality and illness based on a simple two-period lifecycle model that specifies a utility function that includes both regular consumption and health expenditures. Agents are assumed to be homogeneous and have the same exogenous probability of getting infected and die prematurely. The chapter shows that mortality and illness risk have opposing forces on the level of savings. Using micro data obtained from a self-conducted experimental study using monetary rewards among students in South Africa (fully documented in the Appendix), the chapter finds evidence for the so-called *"HIV anticipatory saving motive"*. The data show that individuals perceiving to be highly

exposed to contracting HIV save significantly more, whereas individuals perceiving to live relatively short lives, save significantly less.

Chapter 5 shows that HIV knowledge is an important ingredient for the opposing effects found in the previous chapter. Without awareness of the illness risk households face, they will not anticipate the costs entailed by HIV/AIDS. The chapter extends the simple lifecycle model of Chapter 4 by distinguishing groups in society on the basis of HIV-status knowledge. It studies aggregate savings according to four specified stages of the epidemic and predicts a nonlinear relationship between HIV prevalence rate and aggregate savings. Although the AIDS epidemic reduces welfare, increasing HIV-status knowledge by diagnostic testing may limit this reduction because illness risk and its related costs enhances anticipatory savings. As a consequence, underestimating HIV contamination risk as in an early stage of the epidemic leads to a substantial decrease in both savings and welfare.

Part III studies the impact of HIV/AIDS on intertemporal choice from a behavioral economic point of view. It identifies the individual characteristics of different groups in society based on perceptions of HIV contamination risk. In particular, it studies risk and time preferences using experimental data and relates this to sexual behavior. Infection risk is related to individual behavior and is therefore not exogenous as assumed in the two previous chapters. Sexually active agents and especially agents having unprotected sexual intercourse are obviously more at risk of getting infected with HIV. Individual characteristics like risk and time preferences influence this behavior. Furthermore, the extent to which agents anticipate future illness costs depends on time preferences of agents, which are different across agents as well and may likewise be related to risk behavior. Since sexual risk taking is likely related to risk behavior and time preferences too, the negative impact on savings may be limited. In this case, HIV positive individuals are those agents that would already have saved less when HIV was not present.

In Chapter 6 risk and time preferences are elicited using the same experimental data collected among students in South Africa as in Chapter 4. Specifically, the chapter determines what individual characteristics determine one's risk and time preference, in particular, those of both HIV positive students and high-risk groups. Chapter 6 finds that both subjects with high-perceived contamination risk as well as HIV positive subjects are less risk-averse (even risk-seeking). They seem to have different time preferences, however; whereas subjects perceiving

to be highly at risk display significantly higher discount rates, HIV positive subjects have significantly lower discount rates compared to all other groups. This paradoxical result is explored in Chapter 7 by dropping the assumption that the pure rate of time preference is the only factor that enters the pricing of future benefits. The chapter provides a theoretical framework that allows other factors to be included in the discount rate such as mortality, risk attitude and expected differences in future consumption level. This leads to estimates for the pure rate of time preference different from the observed discount rates. Once these factors are taken into account, HIV positive agent's time preferences conform to expectations. Risky sexual behavior appears to be partly an economically explicable choice belonging to high risk and time preferences. Finally, Chapter 8 synthesizes the results and draws broad policy conclusions in light of the findings in this dissertation for both HIV prevention and reducing the economic impact of the epidemic.

Part I: Background Information

Chapter 2

HIV/AIDS Some Facts

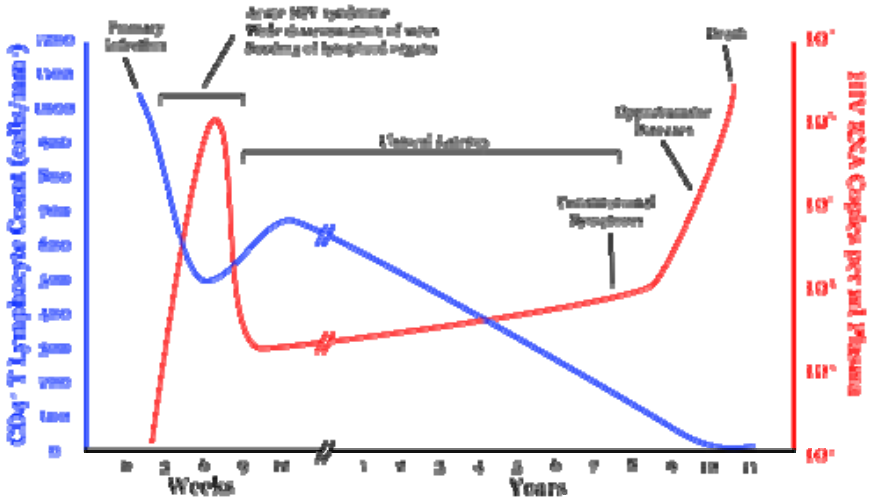
2.1 The disease

AIDS is an acronym for Acquired Immune Deficiency Syndrome. It is a fatal infectious disease in which the immune system collapses. It is a syndrome of opportunistic diseases, infections and certain cancers, which all have the ability to kill an infected person in the final stages of the disease. So, AIDS does not cause death itself, a person dies because of an illness that the body could no longer fight off because of the damaged immune system. A person can only develop AIDS after being infected with the Human Immunodeficiency Virus (HIV), a virus that aims at a person's immune system. Once a person is HIV infected, the virus remains in the body for life.

In contrast to many other infectious diseases, which tend to mainly affect weak individuals, HIV/AIDS is frequently found among prime-aged individuals. This group is primarily affected due to the fact that the spread of HIV/AIDS is strongly correlated with sexual activity. Although in Sub-Saharan Africa, most HIV infections are heterosexually transmitted, a substantial part is transmitted through health care (Gisselquist et al., 2002) and an increasing number of infections take place from mother-to-child.

It is not exactly known from when or where the virus originates, but researchers have found evidence that HIV originates from a virus that was found among chimpanzees in West Central Africa. It is believed that the virus jumped from primates to humans through the consumption of chimpanzees by African tribes (Moore, 2004). Although individual cases had been recognized before, it was not before the late 1970s that the epidemic was observed on a larger scale. Only in 1982, the disease was named AIDS and by that time it had already spread to a least five continents (North and South America, Europe, Africa and Australia).

Figure 2.1 Graph showing HIV virus and $CD4^+$ levels over the course of an untreated infection.



Source: http://www.edinformatics.com/biotechnology/hiv.htm

Once a person is infected, the virus goes through several stages. How fast or slow the final stages of AIDS kick in can be predicted by the so-called *$CD4^+$ cell counts* and the *Viral load.* [1] The $CD4^+$ cell[2] count is an indicator of how healthy the immune system is, indicated in cells per mm^3, measured by taking blood samples. The Viral load refers to the actual number of viruses in the blood. The Viral load and $CD4^+$ cells vary together. Because the virus destroys the $CD4^+$ cells, a higher Viral load will lead to a lower $CD4^+$ cell count. A lower Viral load will go hand in hand with a higher $CD4^+$ cell count, because less viruses in the blood give the immune system a chance to built up its resources again. So, the higher the Viral load, and the

[1] http://www.health24.com/medical/Condition_centres/777-792-814-1756,22216.asp
[2] CD4 positive T-lymphocytes (CD4 cells) are a type of white blood cell. CD4 cells are also known as "helper T cells" because they play an important part in directing the immune system to respond to infections.

lower the $CD4^+$ cell count, the easier it will be for all kinds of infections to successfully attack the body.

The three phases of the disease

The disease knows roughly three different phases, illustrated in Figure 2.1. The figure shows the Viral load and $CD4^+$ levels over the course of the disease without treatment.

In the first stage, the human body starts to develop more and more antibodies in order to fight off the virus. From this stage onwards, a HIV-test is able to identify the presence of antibodies and can thereby determine whether a person is infected. In this stage, most infected people experience flu-like symptoms for about one to three weeks and researchers believe that people are most infectious at this point.

Following this first phase of infection, a person will go through a period in which there are almost no symptoms of illness at all. Without treatment, this period may last from 6 months to over 10 years.[3] This 'silent' stage is probably the reason why the virus has been able to spread so rapidly for so many years as infected individuals might get the impression that they are cured or not infected at all. It is therefore not surprising that estimates show that around 90% of infected individuals are not aware of their status at all. Although HIV does not affect well-being yet, a healthier way of life is strongly advised to keep the $CD4^+$ level high and Viral load as low as possible in order to prolong this latent phase. This includes healthy balanced food, rest and exercise, supplements and immune-boosters, routine visits to the doctor or clinics such that early treatment of opportunistic infections can take place. Besides the implicit insurance provided through the (almost) free public health care system, only few individuals in Southern Africa are covered by health insurance. Thus, for poor families, in general having no formal health insurance, and unbalanced diet habits, this demands a more expensive way of life.

The final stage of the virus is when HIV has destroyed the immune system below a certain level. According to the definitions of the Centers for Disease and Prevention (CDC) HIV infected persons develop AIDS when they have one or several opportunistic infections or a $CD4^+$ cell count below $200/mm^3$. From this moment on, the virus is called AIDS. In this

[3] Median time from seroconversion (clinical latency) to AIDS in east Africa is estimated to be 9.4 years (Morgan et al., 2002).

phase, the human body is extremely vulnerable to infections and substantially reduces weight; most people do not survive longer than a few years. A study in Uganda shows that median survival time after the progression to AIDS is 9.2 months (Morgan et al., 2002). Opportunistic infections are generally the cause of death. It is in this final stage where the patient becomes unable to work and dependent on extensive treatment and care. When the HIV status has been determined in an early stage, the silent phase enables an infected person to anticipate the high costs and decline in income associated with the AIDS-illness. One of the central issues studied in this book is whether people actually do so.

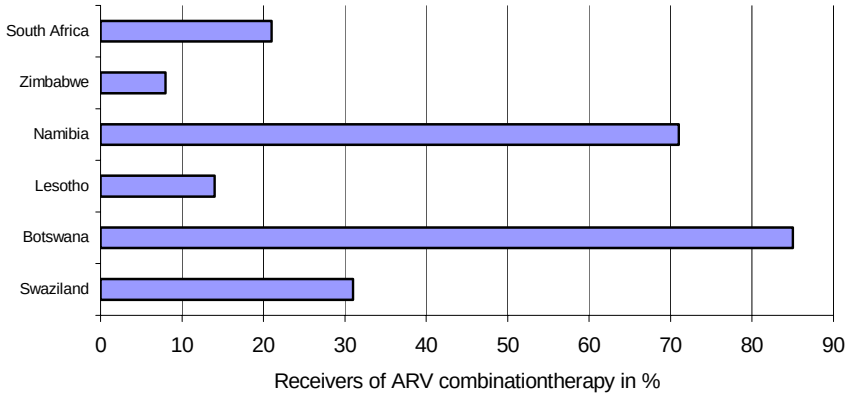
Sketching the course of HIV roughly in three phases illustrates that consumption patterns are influenced differently in all three phases. These changes include both direct changes in food and medical consumption based on medical advice in the first two phases and extensive treatment costs in the final stage. On top of that indirect changes in spending patterns might take place even before phase one, i.e. before HIV infection has taken place, as persons might anticipate the costs related to a possible HIV/AIDS infection later in life. The indirect changes will only take place if an individual considers his HIV contamination risk as significant. In addition productivity levels are influenced differently as well; while AIDS sick people are unable to work in the final stage, HIV infected persons may have a lower level of productivity in the latent phase. Both effects on consumption patterns and productivity obviously have negative implications for income.

There is no drug that can cure HIV infection, but there are drugs like antiretroviral therapy (ART), that can control the virus and delay the onset of AIDS. $CD4^+$ cell counts below 500 cells per mm^3 are usually an indication of immune suppression and vulnerability to opportunistic infections[4]. However, due to the high costs of the medicines themselves and the lack of professional medical institutions and high treatment costs, in low income countries ART is usually given whenever the $CD4^+$ cell count is below 200 cells per mm^3 (WHO, 2003). Only recently the WHO adjusted this level in their guidelines to 350 cells per mm^3 (WHO, 2006). First-line ART used to cost more than $10.000 per patient per year, but since 2000, the widespread production of medicines has reduced these prices to $152 in June 2005 (Campaign for Access to Essential Medicines, 2005). However, treatment is still out of reach for most people in the countries hardest hit. Whereas in many western countries virtually all

[4] The normal number of $CD4^+$ cells varies from individual to individual, but it is usually between 800 and 1500 cells per mm^3.

infected persons receive treatment, the Sub-Saharan region shows very low treatment rates, which differ considerably across countries. For instance, the treatment rate for people with advanced HIV infection[5] in Zimbabwe is 8%, and in South Africa is 21%, whereas the treatment rate in Botswana is 85% (see Figure 2.2).

Figure 2.2 People with advanced HIV infection receiving antiretroviral (ARV) combination therapy (%) in 2005.



Source: WHO, World Health Statistics 2006

Roughly 10% of all HIV infected people in Southern Africa is also aware of its status. Status knowledge is not only important for receiving the appropriate treatment, but also for mitigating the further spread of HIV. One of the important policy decisions in countries affected by HIV/AIDS is the frequency of testing. Whether intensifying HIV testing also increases social welfare depends on several aspects. In Chapter 5, this question is addressed focussing on the effect of diagnostic testing on the ability to optimise saving choices including the disutility of stigmatization and knowing to die prematurely.

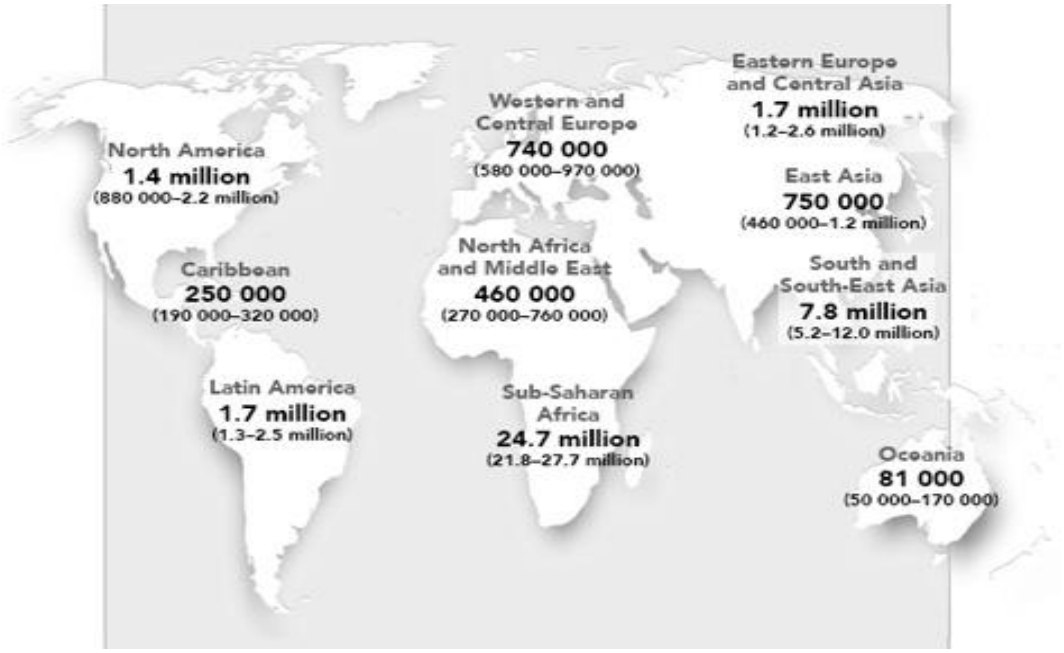
2.2 HIV/AIDS globally

After its discovery in the late 1970s, HIV/AIDS has rapidly developed to a widespread catastrophe. In 2005, 39.5 million people were living with HIV worldwide, and over 25 million people have already died of AIDS related diseases. Many will follow if the spread is not halted soon and proper treatment remains unavailable to the larger part of the HIV infected people. In Sub-Saharan Africa only, were living 12 million AIDS-orphans[6].

[5] $CD4^+$ cell count below $200mm^3$.
[6] in 2005

(UNAIDS, 2006) This large number of HIV infected, AIDS sick people, and orphans put a heavy burden on society.

Figure 2.4 Adults and children to be living with HIV in 2006.



Source: UNAIDS/WHO Epidemic update: December 2006

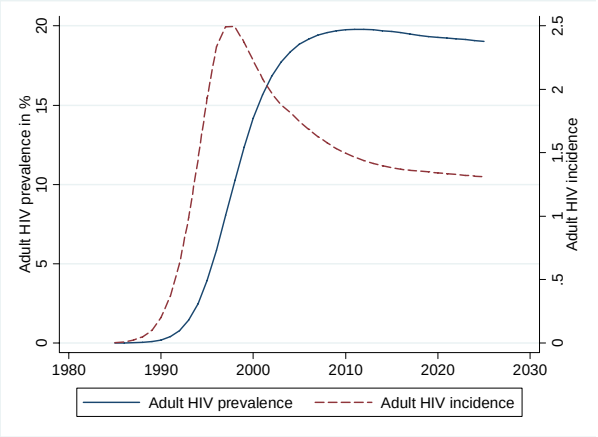
Figure 2.4 clearly illustrates the magnitude and width of the pandemic. HIV is prevalent in all continents of the world: fifty-six countries have HIV prevalence rates[7] greater than 1%, which is the point at which it is believed to begin its diffusion through the general population. Seventeen countries have reached crises levels, i.e. have prevalence rates over 4%, the point at which the epidemic spins out of control.[8] High levels of adult prevalence rates are concentrated in Sub-Saharan Africa, where HIV prevalence is highest among young adults (20-35 years). The four countries of the world with estimated prevalence rates exceeding 20% are: Swaziland (33.4%), Botswana (24.1%), Lesotho (23.2%), and Zimbabwe (20.1%). Six other countries, all from the same region, Namibia (19.6%), South Africa (18.8%), Zambia (17.0%), Mozambique (16.1%), Malawi (14.1%), and Central African Republic (10.7%), have prevalence rates between 10 and 20% (UNAIDS, 2006). For shorthand, I hereafter refer to

[7] HIV prevalence is the percentage of a certain population that is HIV infected.
[8] Following the definition of Bonnerjee (2003)

these countries as the "*hardest hit*" countries. Due to high HIV incidence rates[9], these high levels are predicted to endure in the far future.

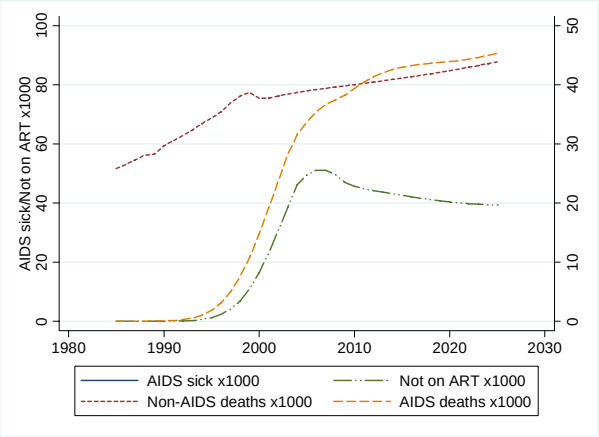
Although prevalence rates remain high, the spread of HIV in Sub-Saharan Africa seems to stabilize: HIV incidence is decreasing in some countries. This decline can be ascribed to the fact that many people with high-risk behavior have already been infected, to effective prevention programs that enable people to reduce their risk of exposure, but also to possible mispredictions of past HIV prevalence rates. Although HIV incidence seems to stabilize the rate of infection remains high. In 2005 worldwide 4.3 million people became newly infected (UNAIDS, 2006). Societies affected by HIV do therefore not incur a temporary shock but a long-lasting one. This creates a heavy burden on several aspects of society amongst others the ability to accumulate capital or to sustain a sufficiently high level of economic growth.

Figure 2.5 Estimated HIV prevalence and incidence in South Africa over 1985-2025.



Source: Actuarial Society South Africa, 2007

Figure 2.6 Estimated HIV prevalence and incidence in South Africa over 1985-2025.



Source: Actuarial Society South Africa, 2007

Although differences are large across countries, this chapter focuses on data of South Africa (being ranked number 6 in terms of HIV prevalence rate), since the empirical results in the following chapters are based on experimental survey data collected by the author in this country. Figure 2.5, showing both HIV incidence and prevalence rates for South Africa over the period 1985-2025, illustrates the recent stabilizing effect of the further spread of HIV. Adult HIV prevalence started to rise sharply in the early nineties. After 1998 the adult HIV incidence rate decreased and the adult HIV prevalence rate is expected to peak 13 years later

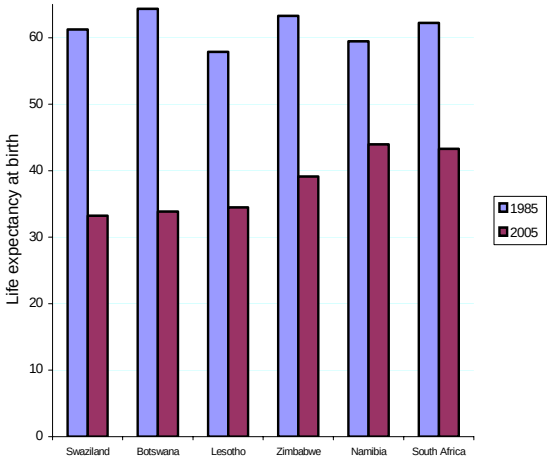
[9] HIV incidence rate is the percentage of a population that contracted HIV in a certain period.

in 2011. The total HIV prevalence rate will peak a couple of years later in 2015, after which both are expected to slowly decline. For the same country, Figure 2.6 expounds the severe impact of the epidemic, as already in 2011 the number of AIDS deaths[10] will make up more than 50% of total death cases in South Africa. Although the number of AIDS sick keeps on rising, the number of AIDS sick that receive ART is projected to slowly increase. The Actuarial Society of South Africa estimates that in 2025 over 50% of the AIDS sick will be receiving ART.

2.3 Demographics

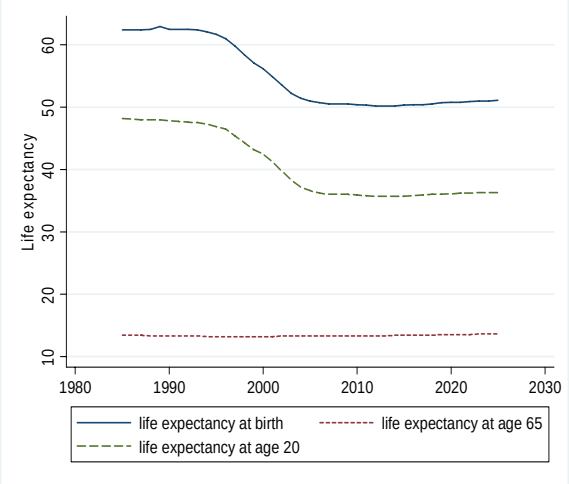
Although Sub-Saharan Africa has suffered from many difficulties including wars, famines, and other epidemics, the impact of HIV/AIDS on the composition of the populations hardest hit, has never been of such a size neither has been the influence on age-structure of such diversity.

Figure 2.9a: Life expectancy for 6 highest HIV prevalence countries in 1985 and 2005.



Source: U.S. Census Bureau, International Data Base, 2006

Figure 2.9b Life expectancy over the period 1985-2025 in South Africa.



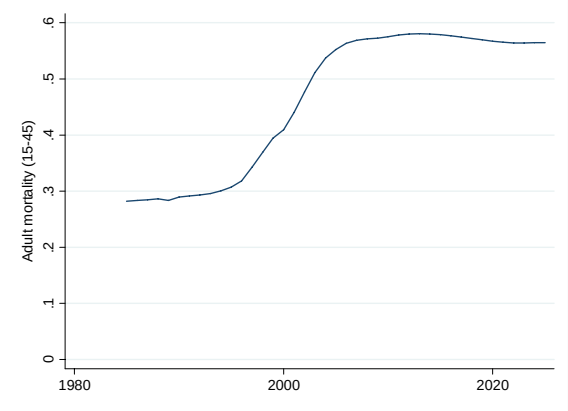
Source: Actuarial Society South Africa, 2007

The devastating effect of HIV/AIDS on the population in Sub-Saharan Africa is easily demonstrated by the decrease in life expectancy over the last 20 years in the worst hit

[10] Data on the actual number of AIDS deaths are not very reliable, since they are collected from death notification forms, which give the direct cause of death, such as tuberculosis, influenza, pneumonia, and so forth.

countries. As Figure 2.9a shows, various Sub-Saharan countries face a decrease in life expectancy at birth of almost 20 years. The most dramatic fall in life expectancy also occurs in the countries most severely hit, i.e. those having HIV prevalence rates over 20%. Also South Africa and Botswana, two of the more developed nations in the Sub-Saharan region, have seen the life expectancy fall by more than 19 and 30 years, respectively. Both countries are now below the level that they had in the 1960s. Panel 9b shows the course of life expectancy for different age groups in South Africa. As mentioned before, people face the highest risk of infection in their sexually most active years, between the ages of 15 and 35 (UNAIDS, 2004). The figure clearly shows that although HIV has a major impact on life expectancy at birth and at age 20, it has barely any effect on life expectancy of 65-year-old people.

Figure 2.10 Adult mortality in South Africa
over the period 1985-2025.

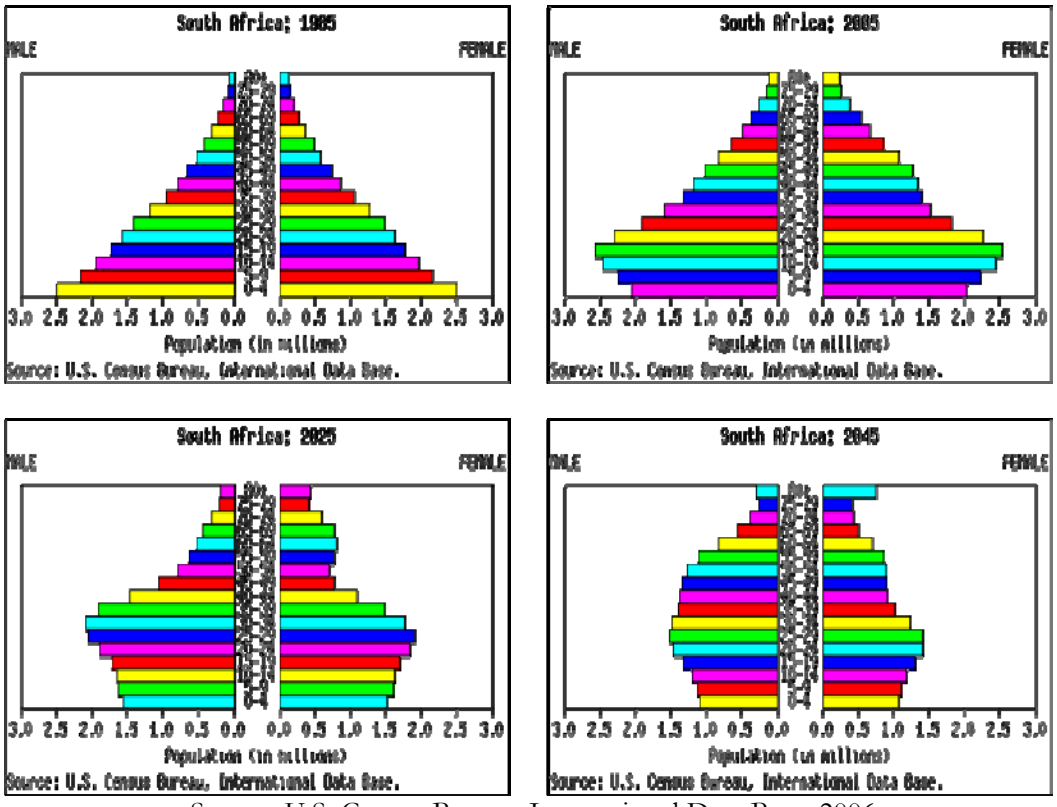


Source: Actuarial Society South Africa, 2007

The demographic impact becomes also evident when looking at mortality rates. Adult mortality has risen from 0.28 in 1985 to 0.55 in 2005, will peak at 0.58 in 2013, after which it remains at a higher level than in 2005 over the next decades (see Figure 2.10). Also child mortality has not been decreased as projected in a situation without AIDS. Children become infected by their infected mothers through pregnancy or breast-feeding. They will develop AIDS and eventually die at a young age. There are signs that also fertility rates have dropped in Sub-Saharan countries in response to AIDS. This may be explained by a higher awareness of the need of protected sex, but also by the increasing number of abortions. Several studies have also found lower pregnancy rates among HIV-infected women (Ntozi, 2002).

Due to the rise in mortality and decrease in fertility, by the year 2025, six countries in the region will even be experiencing negative population growth rates: Swaziland (–1.0%), Botswana (–0.5%), Lesotho (–0.8%), Namibia (–0.3%), Zimbabwe (–0.1%), and South Africa (–0.7%) (U.S. Census Bureau August 2006).

Figure 2.11: Population pyramids for South Africa.



Source: U.S. Census Bureau, International Data Base, 2006

Figures 2.11a-d, presenting population pyramids for South Africa, exemplify the demographic changes caused by HIV/AIDS in the hardest hit countries. By 2025, AIDS mortality will produce population pyramids in these countries never seen before. Before the epidemic (1985), the age-structure in South Africa was comparable with other developing countries, i.e a wide base created by the younger population, that gradually narrows as the survival rate become less for the older age groups. A decrease in fertility already creates a smaller base in 2005. Because of the increase in child mortality and mortality of young adults due to

HIV/AIDS, the population pyramid eventually transforms to a bun in 2045. This will result in higher dependency ratios[11] creating problems for the sustainability of social security.

2.4 Conclusion

In conclusion, in the hardest hit countries, where HIV prevalence rates exceed 10%, life expectancy has fallen dramatically, dependency ratios have risen sharply and population pyramids show forms hardly ever seen before. Although the spread seems to stabilize, HIV prevalence remains high. Obviously in these countries, households are daily confronted with the disease and the effects of HIV are impinging on every aspect of society. Once a person has contracted the virus, the illness-process follows roughly three phases, which influence consumption patterns differently. Not only affected households' behavior is influenced, but due to the major demographic impact, all households are affected one way or another including their lifetime consumption choices.

[11] Not reflected in the population pyramid, is the loss of available labor. Due to HIV/AIDS labor supply is reduced due to periods of sickness, care-giving for those having AIDS sick family members or relatives, attending funerals, mourning periods after death etc. Thus, the dependency ratio in economies hit by HIV/AIDS is likely to be underestimated, if only the absolute number of adults is considered like in population pyramids presented in Figure 2.11.

Chapter 3

Background

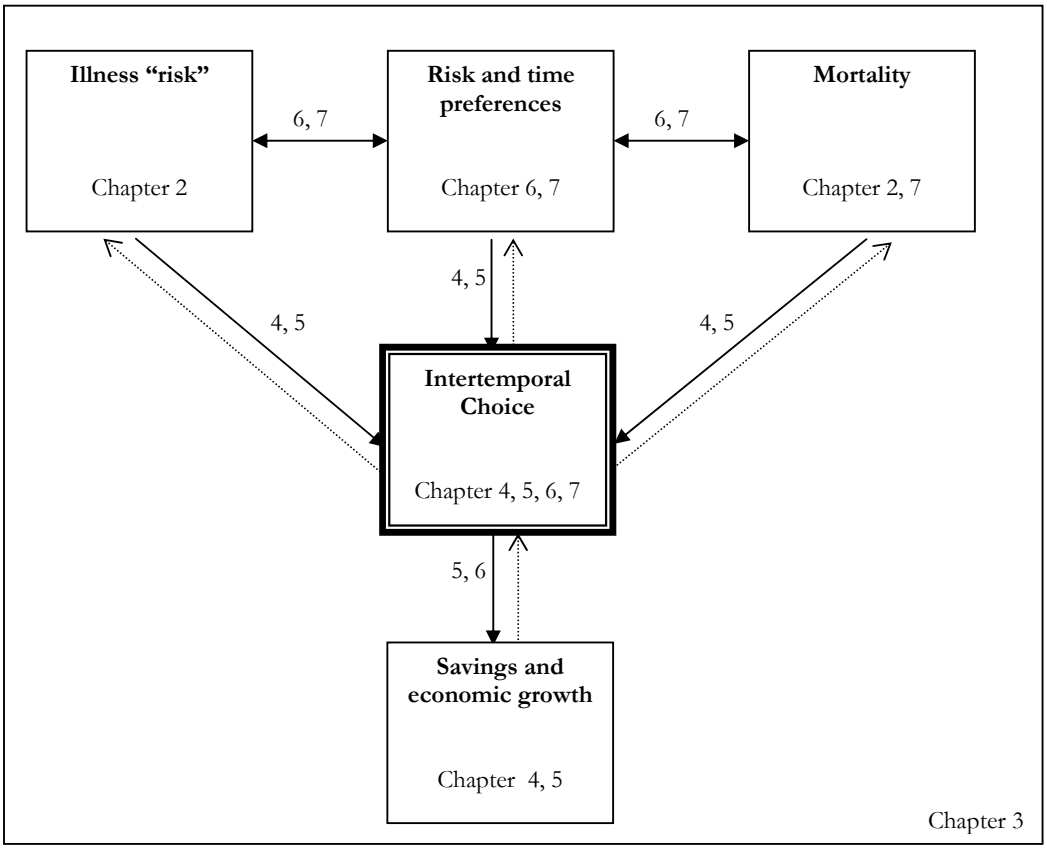
3.1 Introduction

Intertemporal choices encompass decisions based on tradeoffs among costs and benefits occurring at different times. How an epidemic like HIV/AIDS changes these choices is rather complex. This dissertation focuses on three specific channels through which the epidemic influences intertemporal choices, i.e. illness risk, mortality and preferences for risk and time. To clarify the different channels through which the epidemic influences these choices, this chapter provides background information on HIV/AIDS and intertemporal choice. It in particular describes the different ways in which illness risk and mortality influence savings behavior. Preferences for risk and time are important in the choice of the amount of savings. They, however, also influence the risk of getting HIV infected. This chapter studies this relationship by examining the coherence of risk and time preferences and sexual behavior. The discussion is supported by an overview of both previous theoretical and empirical work. Furthermore, this chapter explains the structure of this thesis and the relation between the following chapters.

Figure 3.1 presents a schematic overview of the three specific relations studied in the following chapters. In general, the major box in the center "Intertemporal choice" represents

the lifetime choices made at an individual level. The upper three boxes: "Illness risk", "Risk and time preferences", and "Mortality", represent the interdependent factors that influence these choices and are from now on called "parameter" boxes, because in this study they are represented by parameters. The lower box is the outcome of the processes that take place within the major box, including savings both at an individual and aggregate level, welfare and economic growth. The numbers in the boxes refer to the chapters that study the concept itself and the numbers next to the arrows refer to the chapters that study the concerning relation. For completeness, the dotted arrows show that the specific relationship exists, but that it is not object of particular study in this dissertation. Although the endogenous relations between the boxes are relevant, this thesis is a first attempt to *explore* the different relations.

Figure 3.1: Flowchart on HIV/AIDS and intertemporal choice.[1]



[1] Although it may seem that there is only a subtle difference between the increased illness and mortality risk, since they are both caused by high prevalence of HIV, distinguishing between the two is relevant. As already mentioned in Chapter 2, roughly 10% of the total HIV infected persons in Southern Africa is also aware of their status. This is due to the low testing rates. As a consequence, many HIV infected persons will not actively experience the latent phase and will die soon after AIDS unexpectedly sets in. This scenario influences savings differently and is therefore analyzed separately from illness risk.

Figure 3.1 also illustrates the relevance of obtaining insight into the impact of HIV/AIDS on intertemporal choices. The arrows pointing in opposite directions between intertemporal choice and illness risk, e.g., show that intertemporal choices do not only affect one's wealth, but also one's health: The choices households make over time, for instance, influence the probability of contracting HIV. Harris & Van Aardt (2007), e.g., find that HIV infection is mostly found among low-income groups. Choices on labor supply and investment in human capital, influencing income, thus apparently also influence HIV infection risk and thus ones health. But households' choices also determine the ability to cope with the economic consequences *after* being HIV infected. Prudence in healthy times enables buying medical treatment when unhealthy. If ill individuals can break into their savings, the necessary additional expenditures on medical consumption would not affect the ability to maintain their usual level of regular consumption. Moreover, medical treatment limits the productivity shock associated with illness, prohibiting a sharp fall in income and consumption level. Thirumurthy et al. (2005), for example, show that providing HIV positive patients with ART in Western Kenya leads to a large increase in their labor supply being a 20% rise in the probability of labor force participation and a 35% rise in the weekly number of hours worked.

The negative externalities for the *whole* society resulting from the different choices made at a household level are not less important. Unprotected sex, for instance, enhances a further spread of HIV. Higher HIV prevalence rates obviously raise the infection risk for other households in society. In addition, if infected households cannot bear the illness costs (e.g. including a fall in income and the need for medical treatment), society might choose to contribute to these costs. This burden could affect expenditure possibilities and thereby influences the intertemporal choices of *all* households.[2] A study by Over (1992), for instance, estimates a fall in the yearly growth rate of GDP due to the HIV/AIDS epidemic of 0.33 percentage points, based on predictions of a 50% reduction in savings due to increased health expenditures and the reduced productivity of the workforce. Next to the wealth at household level, intertemporal choices thus also determine the economic prosperity of nations and are thus in particular important to measure the effects of the HIV/AIDS pandemic on economic growth.

[2] In South Africa public health care is for 94% funded from general taxation. Private health care, however, primarily via medical schemes and out -of -pocket expenditure (Booysens & Visser, 2006).

In order to obtain some intuition on the complexity of how HIV/AIDS changes intertemporal choices, the next section graphically illustrates how changes in mortality (upper right box) influence individual savings using a standard life-cycle model. Section 3.3 describes how health shocks such as HIV/AIDS (upper left box) influence intertemporal choices through their direct and indirect effect on lifetime wealth. It discusses the mechanism through which households cope with such shocks and explains in what sense HIV/AIDS is different from other health shocks. Section 3.4 discusses the literature that relates risk and time preferences (upper middle box) to health, mortality, saving behavior, and sexual behavior (the section demonstrates that the latter is also a particular type of intertemporal choice). After the different relations have been discussed at a micro level, Section 3.5 discusses the implications at a macro level (lower box) providing a brief overview on the current empirical findings. Section 3.6 concludes with an overview of the chapter.

3.2 Mortality: HIV/AIDS and in the standard lifecycle model

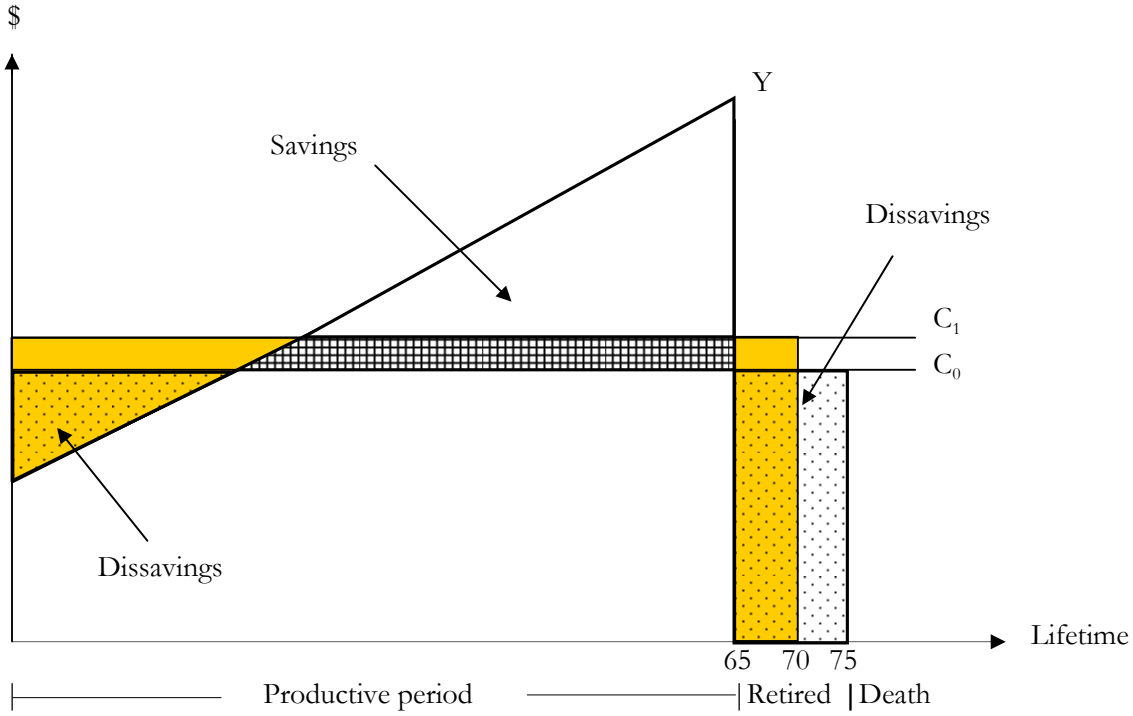
Among the demographic changes caused by the prevailing epidemic, the sharp fall in life expectancy illustrates the increased mortality risk most evidently. In South Africa, for instance, life expectancy has fallen with almost 20 years over the period 1985-2005 (see also Chapter 2, Figures 2.9a-b). The reduction in longevity in Sub-Saharan Africa is actually rather striking, since over the last century, in general, life expectancy has been rising all around the world. This explains why the effects of increased longevity have been widely studied, while the literature that examines increased mortality is relatively limited. The "longevity models", however, can easily be used to analyze decreases in expected lifetime. For instance, models based on lifecycle theory (Ando & Modigliani, 1957), which hypothesize that agents smooth consumption over their expected lifetime, predict an increase in savings if life expectancy rises[3]: the probability of reaching the retirement age and the length of the retirement period increases and agents will therefore be more inclined to safe in order to have enough wealth when reaching this age to maintain their lifetime consumption level. The opposite, of course, can be reasoned for *decreases* in the expected lifetime. In this case, thus predicting a fall in savings.

Figure 3.2 illustrates the negative effect on savings just described in a simple standard life-cycle model. In this model, agents choose a consumption level (C_0) such that the total lifetime

[3] Under the assumption that the rise in life expectancy is caused by an increase in longevity and not by a reduction in e.g. child mortality.

savings equal the total lifetime dissavings. Assume that agents die at their life expectancy, in this example at age 75, and that agents cannot choose their income path (Y). Consider now a fall in life expectancy from e.g. 75 to 70 years. Holding everything else constant, this reduces the total consumption needed after retirement, i.e. the square spotted box halves, which reduces the total dissavings compared to the total savings. In this situation, the lifetime consumption level is not optimal anymore, since there is an unused amount of savings. To equalize total lifetime savings and dissavings, the individual will choose a higher lifetime consumption level (C_1), which decreases the total amount of savings (indicated with the checked area).

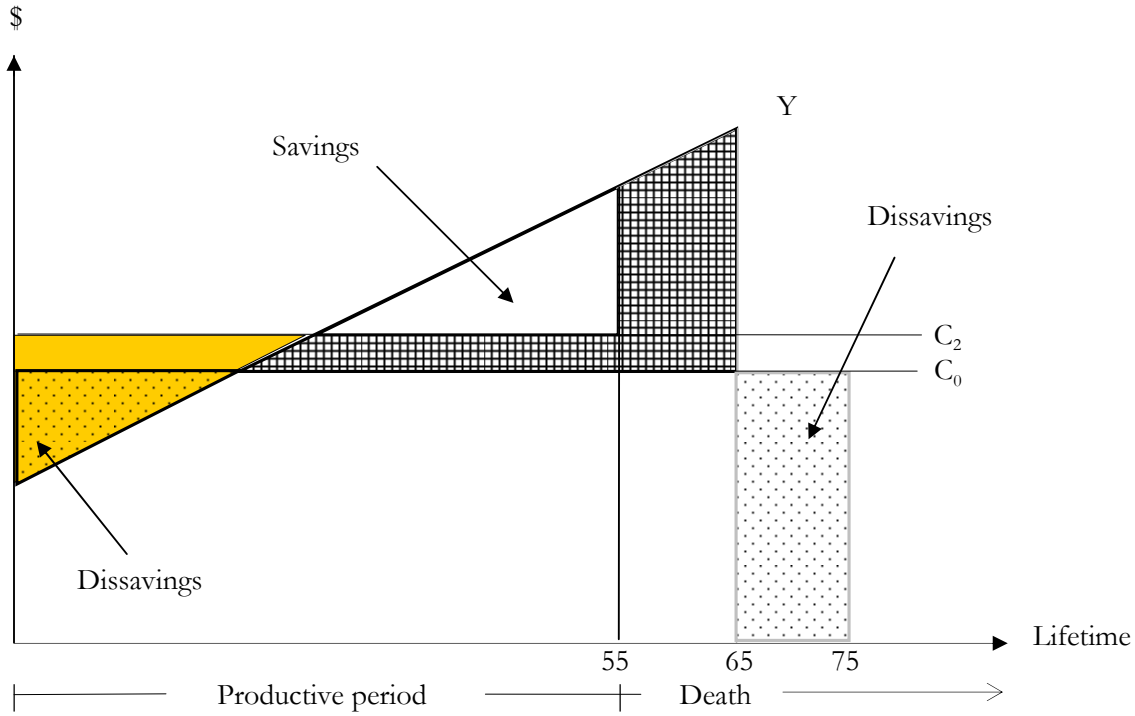
Figure 3.2: Reduction in longevity in a standard lifecycle model.



An additional negative effect is observed when considering a *sharp* fall in life expectancy below the retirement age as observed in the hardest hit countries. Considering a fall to for example 55 years as illustrated in Figure 3.3, not only makes savings for retirement consumption abundant (since there is no retirement period anymore), this fall also reduces agents' productive period. In this situation, agents only have to smooth consumption over the productive period, and thus choose a consumption level (C_2) such that the two triangles,

dissavings (grey shaded triangle) and savings (white triangle), are equal.[4] This reduces savings, compared to the base year, even further (see checked area).

Figure 3.3: Sharp fall in longevity below the retirement age in a standard lifecycle model.



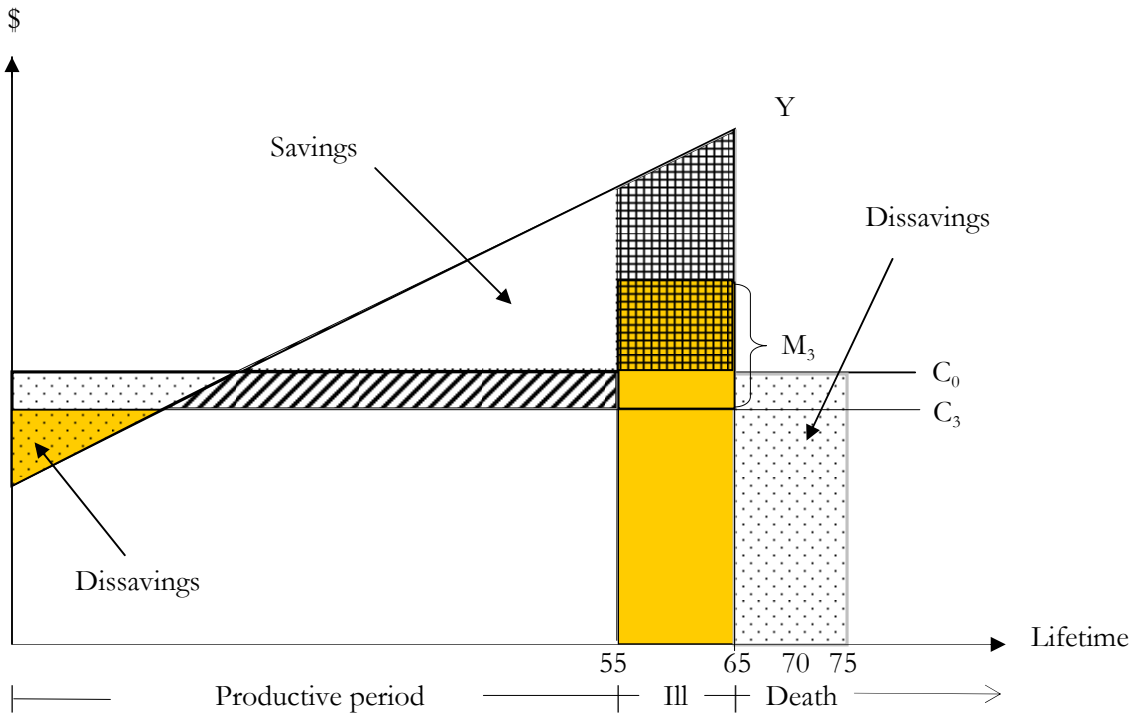
One of the few studies that analyze the impact of HIV on savings is exactly based on the sharp fall in life expectancy. Freire (2004) models savings behavior and finds a significant reduction in saving due to this fall. Ferreira & Pessoa (2003) used a similar idea in their study on the impact of HIV on economic growth, thereby predicting a fall in economic growth.

The story, however, becomes a bit different when considering a period of severe illness prior to the actual death. As explained in Chapter 2, HIV/AIDS is a slow moving disease, which means that the period from infection to actual death can take many years. Suppose instead of dying at age 55 as in the previous example, agents now become unproductive due to illness at age 55, and will still live for let's say another 10 years (see Figure 3.4). During the period of illness, the agent wants to keep its lifetime consumption level but also needs expensive

[4] Note that whether the consumption level C_2 is chosen above or below C_0 depends on the actual decrease in expected lifetime. In this case C_2 is chosen above C_0. When considering an extreme fall to e.g. 35 years, C_2 is chosen below C_0. In both cases the amount of savings will decrease compared to the benchmark due to the decrease in the period in which agents can be productive.

medical treatment (here assumed to be around 30% of total expenditures) in order to be able to enjoy this consumption. This figure shows that the negative effect on savings compared to the base year is not so evident anymore: Like in the former case, holding everything else constant, savings would decrease with the checked area. But due to additional expenditures on medical consumption, agents are now forced to choose a *lower* consumption level (C_3) to smooth consumption over lifetime. This *increases* savings with the dashed area. In this case, the total effect on savings depends on both the time of illness and death and the amount of money they have to spend on medical treatment (M_3). Although the increase in mortality has been incorporated in the previous studies on the impact of HIV/AIDS on savings behavior, as yet morbidity has been left out of consideration.

Figure 3.4: Sharp fall in longevity in a standard lifecycle model and a period of illness.



In reality, the total effect on savings, of course, depends on many other things, some compliant by the agent himself, some out of his control. In this simple example, it was assumed that agents cannot choose the path of income. Dropping this assumption, agents may also choose to shift or change the slope of the income line Y, instead of adjusting their consumption level in response to changes in life expectancy or morbidity. They could do this,

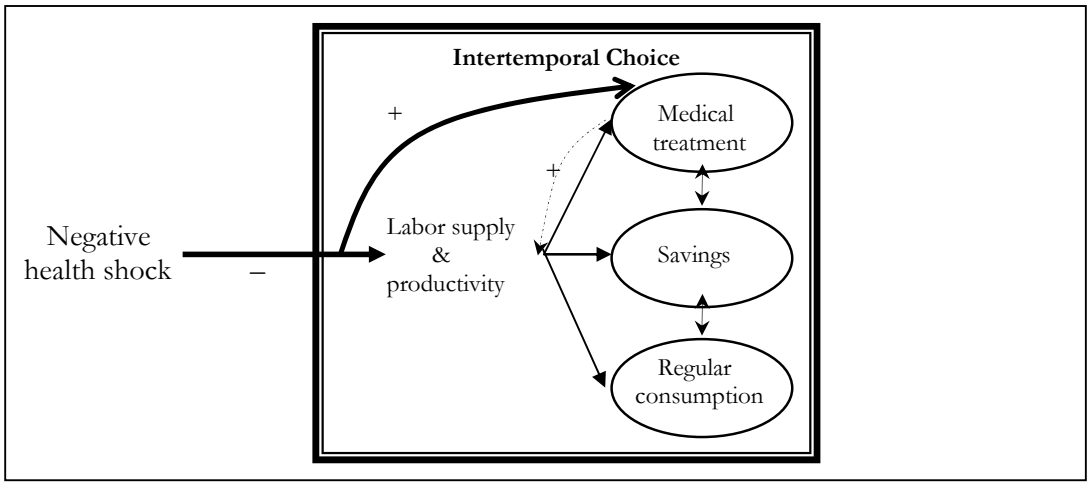
for instance, by increasing labor supply or changing the investment in human capital respectively. Furthermore, agents' lifetime is uncertain; i.e. they do not die exactly at their expected time of death as was assumed in the simple graphical illustration. Uncertainty about future economic conditions and the duration of one's life can increase as well as decrease the incentive to save (Olson & Baily, 1981). Rotschild & Stiglitz (1971) call the negative effect of uncertain lifetime on savings the *substitution effect*. The effect is explained by the fact that agents can only enjoy consumption when alife. As explained in Chapter 2, the expected time of death after being infected by HIV varies widely among patients, and as a result, so does the total amount needed for consumption and medical treatment. In addition, of course HIV infects not every agent in society, and thus agents only face a *risk* of getting infected. Both types of uncertainty induce agents to save more to anticipate both the possible period and the length of illness. The increase in savings due to this "anticipatory behavior" resulting from increases in uncertainty is called the *income effect* (Sandmo, 1970). Whether the income effect dominates the substitution effect, depends on agents' risk preferences (Rotschild & Stiglitz, 1971). At the same time, agents' risk preferences also influence the probability of getting infected by HIV. Risk attitude thus has countervailing effects on savings. Saving choices also depend on preferences over time. If agents do not assign any value to future consumption, they would not like to save, to insure against a possible rise in expenditures in a later period. They may even be less willing to avoid getting infected by HIV, a disease not having major economic consequences in the short-run (although large in the long-run). In this case, high time preferences increase the *need* to save (in terms of higher infection risk), but they limit the *willingness* to save, thereby creating suboptimal outcomes. The above examples show that there are many ways through which HIV/AIDS influences intertemporal choices.

3.3 Illness risk: direct and indirect costs

Major health shocks like HIV/AIDS have a direct and an indirect effect for uninsured or partially insured households in terms of their long-term income (illustrated by Figure 3.5). The immediate or *direct* effect of illness in terms of economics is a decrease in labor supply (absenteeism) and productivity (while working) presented by the thick horizontal arrow, which lowers income at the same time that expenses rise (medical treatment). This is in particular the case when the sick person is the head of the household. The required medical treatment is the most important *indirect* effect of health shocks. This results in a shift of regular consumption or savings to medical consumption. Consumption, however, cannot fall below the subsistence level, which complicates the tradeoff between spending income on

consumption and medical treatment for poor households. The figure shows that illness may create a vicious circle for poor families resulting in a situation in which they cannot afford medical treatment at all.

Figure 3.5: Flowchart box of intertemporal choice of uninsured households.



Direct effect

Health shocks may thus have major implications for households living in countries with a limited social security system. Kochar (1995), for instance, shows that among farmers in India, male sickness during peak season decreases wage income with 30% and increases informal borrowing with 24%. This shows the lack of income security and suggests the inability to incur the costs from own savings instead. Moreover, Gan et al. (2004) find that among a sample of households of 48 Chinese villages, even 15 year after a health shock, a household on average *still* falls short of its normal income trajectory by 12%. Bell et al. (2003) give an explanation for the long-run effect of AIDS on income. In their paper, they model the long run effects of HIV/AIDS on economic growth through the negative impact on human capital formation. AIDS not only destroys existing human capital of the AIDS sick household member, it also limits the human capital formation of the household members and its children by the decrease in household income.[5] As a result, the affected household (partially) loses its capability to generate an average level of income[6] in the long run. Adding together,

[5] Steinberg et al. (2002), however, give little empirical evidence for the latter effect. Although many HIV infected households in South Africa considered to cut on school fee payments, due to fall in income and increase in medical costs, only 4% had actually done so.

[6] With an average level of income is meant, an income similar to the level of income of comparable households but not affected by AIDS sickness.

these effects may cause a household hit by a major health shock to fall into persistent poverty, which could lead to a substantial welfare loss. Illness of a household member may also influence another member's productivity, which is another direct effect of health shocks: for instance, taking care for ill household members and frequent funeral attendance reduces labor supply of these household members (Steinberg et al., 2002[7]). Strong social communities spend much time treating sick people and in the case of Zimbabwean agricultural workers, people on average spend 10% of their working time attending funerals due to AIDS (Ncube, 1999). Although the direct effect of health shocks like HIV/AIDS on labor supply and income are fully recognized, analyses of the indirect behavioral effects are relatively limited.

Indirect effect

The indirect effect of health shocks is related to the treatment of the illness, i.e. the costs of the medical care used to diagnose and treat the illness. As illustrated in the simple standard lifecycle model in Figure 3.3, this may lower the consumption level for uninsured households. From an economic perspective however, a person has a clear incentive to buy treatment: he cannot derive utility from consumption in any period unless he also preserves a basic level of health needed to enjoy consumption. Furthermore, medical treatment enables persons to remain productive or speeds up recovering, such that a person is able to work sooner and is able to earn income again. Therefore, medical expenditures might not be seen as regular consumption but as a crucial investment in human capital needed to earn income and enjoy regular consumption. The dashed arrow in the flowchart of Figure 3.5 demonstrates that medical treatment (improving health) reduces the negative effect of the health shock on income-generating possibilities. Although the models in this thesis do distinguish between regular and medical consumption, for explanatory purposes, the endogenous influence of medical consumption on productivity is not taken into account.

The effect of the indirect costs may be large since medical costs for uninsured households are relatively high. If households unexpectedly have to spend a large amount of money in a short period of time, this may lead to heavy indebtedness. This slows down their pace of asset accumulation including children's education. Steinberg et al. (2002), for example, shows that

[7] Among a sample of South African AIDS affected households, 40% of the caregivers had to take time off from work, or other income-generating activities, or school. Almost 60% decreased the time spend on gardening activities, affecting the ability of poor households to grow food for consumption or sale.

in South Africa, AIDS affected households[8] spend more than a third of households' expenditures on private medical care. Two third of these households reported a loss of income[9] as a consequence of HIV/AIDS contributing to the total financial burden. Their findings are supported by an empirical study in India, which shows that the share of medical expenses in total household spending is significantly higher in the period after a household member was tested HIV positive. The salaried group spends the highest amount on medical expenses, which reduces regular consumption expenditure by about 12% (Pradhan et al. (2006)). Also Gertler (1997) shows, using survey data[10] from Indonesia that there are significant economic costs associated with health shocks albeit more from income loss than from medical consumption. The empirical studies show that the indirect costs of health shocks are substantial and should thus be taken into account in measuring the economic impact of HIV/AIDS.

Savings as insurance against health shocks

The size and unpredictability of both direct and indirect costs of health shocks may imply that households are not able to smooth their consumption over periods of major poor health, especially in developing countries where few individuals are covered by formal health and disability insurance (World Bank, 1993). While in developed countries families with sick members are able to access formal insurance markets, families in low-income countries must rely on informal mechanisms like participating in informal insurance groups (LeMay, 2007), or individual saving. As mentioned before, the costs of health shocks are relatively high. Households spend a relatively large proportion of their income on health related commodities. LeMay shows that while 51% of the households in Cotonou (Benin) made expenses related to funeral and or illness during the last six months, only 18% of the surveyed observations were participating in some form of insurance, to cover these costs. Although Kochar (1995) found that households can relatively well protect themselves from idiosyncratic crop shocks by increasing their labor supply, this type of insurance is clearly ineffective in protecting households from shocks such as sickness, and death. Health shocks

[8] The research population consisted of households that contained an AIDS-sick individual, or households where someone had recently died of HIV/AIDS. Households with an HIV infected member that was not sick were not included in their sample.

[9] The medical expenditures ranged from 8 – 4.000 Rand a month (monthly income ranged from 40 – 24.5000 Rand).

[10] He used data from a panel survey (IRMS: Indonesian resource Mobilization Study) of households designed to evaluate an experimental increase in user fees charged at public medical care facilities, collected in 1991 and 1993.

require alternative, possibly costlier, methods of insurance and may then affect the economic condition of households to a greater extent than for example crop shocks. Also Dercon & Krishnan (2000) show that although within poor households in Ethiopia generally risk-sharing takes place, full insurance against illness shocks does not. This might be due to the inability to predict actual illness risk and the associated costs. Pettifor et al. (2004) for instance, show that youth in South Africa are indeed unable to correctly predict their HIV infection risk. Only 21% of the HIV positive youths in their sample qualified their risk as high, whereas 62% reported to have a small or no risk at all. This study unfortunately did not report anything about the expected costs of illness. Failures in predicting expected illness cost thus leads to sub-optimal level of insurance.

Although few households in Indonesia have medical insurance, Gertler (1997) finds that households' willingness to pay for insurance is roughly 67 percent of the expected income loss. Moreover, in the absence of disability insurance (so that the marginal utility of consumption when ill is high) this willingness to pay to smooth consumption over medical expenditures is 150% of expected medical costs. The latter results would plead for collective insurance. Several impact studies like Booysen & Visser (2006) and Marzo (2004) show that HIV affected households fall into chronic poverty. This fact could stimulate unaffected households to anticipate the costs of illness. But although Kochar shows that families in low-income countries are fairly well able to smooth illness shocks, Gertler (1997) finds that the more severe the physical limitation, the less families are able to actually do so. If households lack access to alternative means of protecting consumption, income uncertainty may generate precautionary savings (Kochar, 1995). Currently there is no clear evidence to what extent households anticipate the costs of HIV-related illness risk by saving or whether they anticipate these costs at all. Chapter 4 contributes to lessen this gap by examining whether uninsured groups, groups that perceive to be highly at risk, and HIV infected persons on average save more than others.

Specific characteristics of HIV/AIDS

Compared to other health shocks, HIV/AIDS infection has special characteristics that might lead to different or more sizable effects on household income and society. These large effects may have a different impact on the anticipating strategies of households relatively than other health shocks.

First, AIDS is fatal, which means that the shock is *persistent*. This makes it difficult to recover from the shock. If the AIDS sick person is the main income earner, this requires a decomposition of the household structure, i.e. other household members need to earn the household income, but at the same time have to take care for the AIDS sick household member.

Second, HIV affects people who are most sexually active, mainly *prime-age adults* (see Chapter 2). Because (young) adults are also the most productive group of a population, the AIDS epidemic not only affects the age composition, size and growth rate of the future labor force, it will also change its skill composition, which in turn feeds into growth rates of potential output and of productivity. Moreover, the relatively strong decrease in societies' productivity level subsequently undermines the tax base. So, HIV not only influences households with HIV infected members, but it affects every person at any level in society. Arndt & Lewis (2000) included this effect in measuring the impact of the HIV/AIDS epidemic. Based on an economy wide computable general equilibrium, where the effects of HIV/AIDS are transmitted through various channels such as public spending, productivity and diminishing human capital, their model shows that the loss in GDP is primarily caused by a decline in total factor productivity and a shift from government investment towards government spending on health. They find a difference in yearly growth rates between a 'with-AIDS'-scenario and without-AIDS' scenario of 2.6 percentage points over a twelve-year period. The World Bank (1999), however, predicts a substantial smaller effect. For the top-10 African countries ranked by their HIV prevalence rates, the annual average growth of GDP per capita would turn out 0.3 percent lower by the year 2025. They explain the small negative effect by the expected disproportionate burden of HIV/AIDS on low-skilled individuals, which would lead to a smaller loss to society compared to losses among high-skilled workers since the low-skilled are easily replaced by the large pool of low-skilled unemployed.

Third, AIDS is *slow-moving*, both within society and also within human body, i.e. the incubation period is extended and the morbidity level is high (see Chapter 2). As a result, both households and society must bear the costs of treatment and palliative care, which are high and lasting relative to other killer diseases. This affects the level and composition of future consumption by both private and public agents, and thus also the levels of savings and investment. In a theoretical framework, Chapter 4 includes this period of long-term illness by a reduction in regular consumption during the period of illness. However, because of the

slow-moving characteristic of HIV households can anticipate these costs, in the latent phase of HIV infection (as defined in Chapter 2) when they are still productive.

Fourth, in certain regions HIV/AIDS *prevalence is high*. In South Africa, for instance, HIV prevalence was estimated at 18.8% in 2005 (see Chapter 2 for more data on HIV prevalence rates). At such high levels of the spread of HIV, also not (yet) infected households may anticipate HIV related health shocks, by insuring or saving. Empirical evidence shows that awareness of the presence of HIV in the South African society is high: 26% of the youth reported to personally know someone with HIV/AIDS, and 45% of youth reported that they personally knew someone who had died of AIDS (Pettifor et al., 2004). High awareness is likely to enhance savings or insurance strategies, however no empirical evidence is found in the present literature on HIV/AIDS. The idea, however, is supported by Kochar (2004) who found that higher expectations of future ill-health increased overall savings among Pakistani households. I will call the hypothesized positive effect on savings the *HIV anticipatory savings hypothesis*, which will be both theoretically explained and empirically tested in Chapter 4.

Fifth, as mentioned before, HIV/AIDS mainly affects *low class* households (Harris & Van Aardt, 2007). Households having income close to subsistence level clearly have more difficulties to anticipate health shocks. As a consequence, the anticipatory savings effect may be limited.

Finally, contrary to many other epidemiological diseases, HIV infection is related to *risky behavior*. This makes it possible to reduce the risk of infection or even anticipate the costs of risky behavior, although the latter might seem paradoxical: On the one hand, persons take the risk of getting infected, while on the other hand they display risk-averse behavior by taking precautions in terms of income security.[11]

In summary, a key limitation of past work is that relatively small health shocks are considered, but not the kind of large and persistent major illness caused by HIV/AIDS. If households would anticipate these large persistent shocks, total savings could rise substantially. However, especially low-income groups, which are highest at risk, may have difficulties in fully insuring against this particular health shock, since they have incomes close to the subsistence level.

[11] This behavior occurs in many cases. Consider for example a person taking the risk of driving 250 km per hour but wearing a seat belt incase something happens.

The extent to which household anticipate the HIV/AIDS related costs is uncovered in the current literature. Because of the complex nature of this health shock, its total effect in particular on individual savings behavior is difficult to predict and has special attention in Chapter 4 and 5.

3.4 Risk and time preferences

Assumptions about risk and time preferences play a central role in the analysis of major economic decisions. In most cases, welfare analysts implicitly assume risk neutrality and use constant discount rates as the basis for evaluations. However, individual risk and time preferences vary across individuals and may even adapt to significant changes in mortality and illness risk, such as caused by the rapid spread of HIV/AIDS in Southern Africa. The previous sections explained that intertemporal choices like saving decisions are subjective to expectations about mortality and HIV infection risk. To what *extent* these expectations influence intertemporal choices is determined by individual preferences, like preferences over risk and time[12]. Lower time preferences, and risk tolerance, for example enhance saving behavior. How an epidemic like HIV/AIDS changes these preferences is, however, uncovered in the current literature. Thus, the reduced life expectancy and perceived risk of getting HIV infected may influence intertemporal choices like individual saving and investment behavior in a way we yet do not know. This could seriously bias welfare analyses of public policy in the region.

Risk and time preferences do not only play a major role in measuring the impact of HIV/AIDS on economic decisions, these preferences may also influence other types of behavior, like sexual behavior. Using hypothetical questions among a sample in the US, Barsky et al. (1997), for example, find that risk tolerance is not only related to economic choices like failing to have health and/or life insurance, and holding stocks rather than Treasury bills, but also to risky behaviors like smoking, and drinking. Quantifying risk and time preferences may therefore be important in understanding risky sexual behavior. Identifying the characteristics of HIV infected persons will contribute to the development of policies aimed at mitigating the welfare effects and reducing the further spread of HIV.

[12] As already mentioned, Rotschild & Stiglitz (1971) shows that uncertainty influences savings by both an income and a substitution effect. In the same paper they theoretically derive that the income effect dominates if the value of the risk parameter $\gamma > 1$. Thus, if agents exceed a minimum level of risk aversion, savings increase.

How strong intertemporal choices in general are related to risk and time preference is an empirical question and has been studied widely by experimental economists. Without having the ambition to give an overview of this entire field, this section gives a brief outline of the literature closely related to the object of study in this thesis. The interested reader is referred to Starmer (2000) and Frederick et al. (2002) for an extensive overview of respectively risk and time preferences. The focus of this section is threefold: First, since HIV is most prevalent in Sub-Saharan Africa, it provides an overview of the empirical results found on risk and time preferences in developing countries. Second, it gives a brief outline of the relation between risk and time preferences and health. Third, it illustrates the relation between risky sexual behavior and time preferences using a theoretical example and discusses the empirical data found on the relation with risk-taking behavior.

Risk and time preferences in developing countries

Individuals in developing countries in general face extraordinarily more risky environments than individuals in the developed world. For instance, political instability, food scarcity, high mortality, high inflation, insufficient health care, unsteady wage employment, insufficient financial institutions etc. (Fafchamps, 1999). This high incidence of risks may incite individuals to prevent risks from occurring more than people living in a risk-free environment. On the other hand, taking risk becomes less costly, when surrounded by many other types of risk. For example taking the risk of getting infected with consequences in the long-term is lest costly when living in environments with a high level of short term mortality risk.

A similar reasoning applies to time preferences. Conventional wisdom has it that people living close to absolute poverty live a more day-to-day life than others. This would imply that they assign less value to future consumption, which is reflected by higher time preferences. How an epidemic like HIV/AIDS influences these preferences is not so obvious, however. The shorter expected lifetime, due to the increase in mortality, could enhance this day-to-day perspective ("*a bird in the hand is worth two in the bush*" (Rothschild & Stiglitz, 1971, p. 69)), but could also increase the relative value individuals assign to future consumption if they want to get the best out of the final years of their life. HIV/AIDS might therefore as well as increase or decrease individuals' risk and time preferences.

Although there are many empirical studies on risk and time preferences in Western countries, these preferences have rather sporadically been studied in developing countries. To the best of my knowledge Binswanger (1980) was the first who measured risk behavior in a developing country. It was many years later that Harrison et al. (2005b) elicited risk coefficients based on similar methods in India, Ethiopia, and Uganda. They found risk aversion in these countries to be close to estimates obtained with comparable experiments and statistical methods in developed countries. Tanner et al. (2005) compared both risk and time preferences between 5 countries from 4 continents. They, however, did find evidence for higher discounting and substantially lower risk aversion among more collective cultures and low-income countries. If in general risk and time preferences are higher in developing countries, this would mitigate agents' willingness to take health insurance or save for the risk of getting ill in response to the HIV/AIDS epidemic. This would affect agents' ability to meet the costs of future health shocks and therefore enhance poverty.

Moreover, if high individual risk and time preferences carry over to sexual behavior, these preferences would enhance HIV infection. Then, agents that *should* anticipate illness costs are *less likely* to actually do so. This could have an additional negative impact on HIV infected households' coping ability of these costs, which makes studying both relations absolutely relevant for intervention policies. Furthermore, studies that relate poverty and risk and time preference show that the rich are more "patient" than the poor (Lawrence, 1991)[13]. As HIV/AIDS increases poverty, we may conclude that on average discount rates are expected to increase in the hardest hit countries. If time preferences were indeed related to sexual behavior, this would create a downward spiral.

Health and risk and time preferences

While there is no literature on the relation between risk and time preferences and HIV/AIDS, a number of studies have experimentally analyzed the relation between risk and time preference and preventive health behavior. Studies of vaccination, medical adherence to medical treatment, and exercise show little relation with time preference and preventive health behavior (see Chapman (2005) for an overview). On the other hand, studies of addictive behavior show strong evidence for the relation between time preference and preventive health behavior (see Bickel & Marsch, 2001 for an overview). Chapman (2005) explains this

[13] She explains this finding by the fact that time preferences are culturally acquired Maital & Maital (1977).

result by suggesting that time preference measures reflect an ability to refrain from immediate gratification that is applicable to "hot" behavior, such as smoking, and drinking, but not to cold behavior such as vaccination.

Age and time preferences

Several theories of intertemporal choice predict that peoples' discount rate differs systematically with age. Different theories however predict different patterns. Some predict that the individual discount rate decreases over the lifespan (Becker & Muligan, 1997) but others predict exactly the other way around (Trostel & Taylor, 2001). Other theories, some supported by empirical or experimental data, predict non-monotonic relations Read & Read (2004), Sozou & Seymour (2003), and Rogers (1994). The HIV/AIDS epidemic changes the age-structure in countries with high prevalence rates. Therefore, time preferences can be changed in ways we yet do not know.

Rogers (1994) define individuals' utility function by Darwinian fitness; the representation of one's genes in future populations. Young adults would gain the most from a unit of resource and are expected to have the highest discount rate. After a period middle-aged, with almost constant discount rate, the old age discount rate is expected to decrease. Old-aged are unable to directly transform resources into offspring, and may even choose to transfer resources to their offspring. Rogers uses fertility data, to support his theory. When considering HIV positive individuals to be less reproductive, this would make them, according to this theory, relatively more "patient" predicting lower time preferences.

Using longitudinal consumption data, Trostel & Taylor (2001), estimate significantly higher discount factors for old age individuals. They explain their findings by arguing that over lifetime people's ability to appreciate consumption decreases, due to the deterioration of people's health over the lifespan, at an increasing rate, reducing the prospect of getting pleasure out of future consumption. Future poor health may indicate expected decrease in pleasure from experience, which would predict HIV positive subjects to have higher discount rates.

Sozou & Seymour (2003) combines the two theories and adds a third effect. The "learning about the environment"-effect. Young people enjoy present consumption relatively more, because they do not know what they can expect from the future. Using the first argument; the

HIV epidemic increases uncertainty, predicting an increase in the overall discount rate. Being tested HIV positive would partly resolve uncertainty, reducing the discount rate for these individuals. However, poor health increases one's uncertainty about whether future rewards will be received, moreover mating opportunities are reduced, both posing a positive effect on the discount rate. Although they conclude that the net-effect is an increasing discount rate at old age, the effect of the epidemic on the overall discount rate and HIV positive's discount rate is not clear-cut. Chapter 6 and 7 will provide more insight in this matter, by analyzing the relation between time preferences perceived HIV contraction risk and HIV status.

Sexual behavior and risk and time preferences

Intertemporal choices involve a tradeoff between short-term benefits and long-term costs. The choice whether to have unprotected sex involves a similar tradeoff: the short-term benefit of sexual pleasure and long-term costs of getting HIV infected. If individuals are unable to correctly estimate the future harm caused by risky sexual behavior, there is a clear role for policy makers to intervene. O' Donoghue & Rabin (2001) describe in a systematic way how people make unfavorable choices by underestimating future harm caused by current behavior like unprotected sex. This subsection provides some examples on how individuals could end up making an unfavorable choice. The first example illustrates the role of time preferences in this behavior.

Suppose individuals' intertemporal preferences are defined as follows:

$$U^t = \sum_{\tau=1}^{T} \frac{1}{(1+\rho)^{\tau-t}} u_\tau \qquad (3.1)$$

where U^t lifetime utility at time t and ρ is the individual's discount rate. Assume there are two periods, youth and adulthood. Engaging in unprotected sex when young yields utility $u_1 = 10$ and causes an expected future cost of 15. Abstaining from risky sex would yield $u_1 = u_2 = 0$. Suppose a person's discount rate is 0. In this case, the individual would choose to abstain from unprotected sex. But if this person's current discount rate is different from his future discount rate e.g. $\hat{\rho} \geq \frac{1}{2}$, he would choose to have unprotected sex and ends up in an suboptimal situation. From this example the question arises whether people engaging in unprotected sex indeed display higher discount rates, i.e. do HIV positive persons and persons highly at risk of contracting HIV display higher discount rates? Exactly this question will be addressed in Chapter 6 and 7.

A simple modification of this example, illustrates that individuals that underestimate the *risk* of getting HIV infected from unprotected sex, will end up choosing unprotected sex more easily. Suppose that the risk of getting HIV infected by unprotected sexual intercourse is 10%[14], and considering expected costs of risky sex of 15, the actual cost of unprotected sex equals 150 (solving $\frac{9}{10}.0+\frac{1}{10}x=15$). Suppose now that an individual *thinks* his risk is lower than $6\frac{2}{3}\%$ and his discount rate equals 0 ($u_1+u_2=10-6\frac{2}{3}\%(15)=0$). In this case the individual would choose to have unprotected sex, while he would not in case he had known the actual risk. Perceptions of HIV contamination risk are thus important in decisions on whether to engage in risky behavior.[15] Raising perception of the *severity* of infection risk will in this example directly diminish risky behavior and hence improve the welfare of adolescents. However, whenever individuals would display risk-seeking behavior, this intervention should be implemented with reservation. It is therefore relevant to measure risk behavior among high HIV infection-risk groups. Moreover, economic theory suggests that higher relative risk aversion is likely to increase preventive behavior like condom use as well if there is uncertainty like on the incidence of illness. Whether individuals engaging in risky sex or individuals highly at risk have specific risk attitude will be empirically tested in Chapter 6 and 7.

Evidence shows that when people make decisions having both short-term and long-run consequences, they tend to choose for immediate gratification in a way that they would not like from a long-run perspective (O' Donoghue & Rabin, 2001). This behavior was already described by Rae in 1834 (p. 120):

> *"Such pleasures as may now be enjoyed generally awaken a passion strongly prompting to partaking of them. The actual presence of immediate object of desire in the mind by exciting attention, seems to rouse all the faculties, as it were to fix their view on it, and leads them to very lively conception of the enjoyments which offers to their instant possession"*

In his work, Rae argued that next to the limiting effect of health and uncertainty of human life for savings as explained in the previous sections, "*the effective desire of accumulation",* was constrained by the excitement generated by the prospect of immediate consumption and the

[14] The value used for HIV contraction risk is purely fictive number and *only* chosen for illustrative purposes.
[15] Perceptions about HIV contamination risk might be related to risk and time preferences as well. Mispredictions are however not studied in this thesis since my data did not allow testing for this.

disutility in delaying this consumption. This strain of thought not only finds it link with saving behavior. Loewenstein (2005), for example, who calls this phenomenon the "hot-cold-empathy gap", analyzes its relation with medical decision-making. He finds that the hot-to-cold empathy gap contributes to the lack of adopting healthy lifestyles, taking simple preventive measures, such as taking multivitamins, and getting routine medical tests. This behavior may be in particular applicable to sexual behavior. Decisions about sexual behavior might be made in the "heat of the moment" at which little thought may be given to the possible future consequences of sexual (unprotected) activity. An extension of the former example illustrates this myopic behavior. Suppose an individual's intertemporal utility function is extended to Equation (3.2).

$$U^t = u_t + \beta \sum_{\tau=t+1}^{T} \frac{1}{(1+\rho)^{\tau-t}} u_\tau \qquad (3.2)$$

where $\beta \in [0,1)$ is a preference for immediate consumption. For $\beta = 0$ utility in all future periods are disregarded and for $\beta = 1$ there is no special preference for immediate consumption. Suppose the same individual has a $\beta = \frac{1}{2}$ and still an actual discount rate of 0 and is considering to have unprotected sex now (t = 1, yielding again a utility of 10 and a cost of –15) or having sex in the near future using a condom (t = 2, yielding e.g. 4). Having sex now yields a utility of $u_1 + u_2 = 10 - \frac{1}{2}(15) = 2\frac{1}{2}$, which is larger than postponing sex ($u_1 + u_2 = 0 + \frac{1}{2}(4) = 2$). Thus, the person will choose to have unprotected sex now. However, whenever period 2 *arrives* he would not have chosen to have unprotected sex since at that point in time he values $u_1 + u_2 = \frac{1}{2}(10) - \frac{1}{2}(15) = -2\frac{1}{2} < 2$, which is clearly lower than abstaining from unprotected sex. In this case, individuals having preferences $\beta < \frac{10}{19}$ behave time-inconsistently and will end up having unwanted unprotected sex.

This example shows that individuals may have self-control problems wherein they are unable on a moment-by moment basis to behave in their own long-term interest. Agents displaying this "impatient" behavior might already save less compared to low-risk groups of getting HIV/AIDS. This might limit the total effect on savings as the agents at risk could be expected to have saved less already in a no-AIDS scenario. However, if these agents are aware of their visceral induced behavior, risk averse agents might still anticipate the costs related to

the illness risk they face by increasing their savings. Chapter 6 and 7 also addresses this question, i.e. whether individuals behave time-inconsistently.

While there is no literature on the relation between risk and time preferences and HIV/AIDS, there are also only few studies that have determined the relation with sexual behavior. In particular, Chesson et al. (2006) infers that indeed time preferences and risky sexual behavior are positively related. But they do not find a significant relation between time preferences and having Herpes simplex virus type 2 (HSV-2) antibody in subjects' blood (an other incurable sexual disease). They study these preferences in the US, a country much less afflicted by HIV, and a relatively risk-free environment in general compared to the situation in developing countries. In addition, they do not study the relation with risk preferences. Moreover, they are using hypothetical payoffs, which might bias their results (Holt & Laury (2002)). In a study, that measures risk and time preferences among the Danish population, Andersen et al. (2005) find that joint estimation of risk and time preferences significantly reduces the discount rate. Part III contributes to the current literature by measuring both risk and time preferences using real incentives in a country highly affected by HIV/AIDS, i.e. South Africa. It measures individual perceptions of health risks, in particular, HIV contamination risk and mortality and relates this to the elicited risk attitude and discount rate. Furthermore, it empirically tests for the myopic behavior described above.

Diagnostic testing

Chapter 2 mentioned that only around 10% of all HIV infected persons are also aware of their status. In order to mitigate a further spread of HIV, it is important to increase status awareness. Coates et al. (2000), for instance, show that learning HIV status substantially reduces reported sexual behavior. Although some advocate making HIV testing mandatory, most researchers agree that doing so is unethical. Therefore, countries have to rely on voluntary testing. HIV screening itself however, does not prevent the person from HIV, nevertheless it enables HIV infected persons to protect themselves and prevent spreading HIV further to *others*. Detecting HIV in an early stage, however, might prolong the lives of HIV infected persons, because then regular check-ups can monitor changes in the Viral load and $CD4^+$ cell count (see Chapter 2) in time, enabling early medical intervention.[16] A disadvantage of early testing, however, is that once tested HIV positive, people might suffer

[16] This is less of an advantage in countries where medical treatment is only scarcely available.

from the stigma and knowledge to die prematurely. From a welfare perspective it is therefore not immediately clear whether testing benefits society. Chapter 5 analyzes the welfare implications of increasing HIV testing, in particular the tradeoff individuals make between being able to have medical treatment and the knowledge to die prematurely. The endogeneity of HIV testing and the further spread of HIV is not incorporated in the model, but is left for future research.

Empirical research shows that putting oneself to a medical test is related to both risk and time preferences (Picone et al., 2004). Although less risk-averse individuals tend to be more likely to undergo testing, individuals with low time preferences are more likely to undergo cancer screening. Loewenstein (2005), moreover, shows that the cold-hot empathy gap contributes to the failure of persons to get medical tests. He raises the ethical question, whether individuals who cannot make self-interested decisions over the long run should decide on whether or not to undergo medical tests. Under the assumption that sexual behavior is associated with high time preferences, voluntary testing will lead to an under-representation of HIV infected persons among the test-takers. Taking into account the effect HIV status knowledge has on risky sexual behavior, this could have serious welfare implications. Chapter 6 empirically tests the relationship of testing behavior and risk and time preferences.

In summary, behavioral economics provides some valuable insights into the harm agents cause themselves by taking the risk of unprotected sex. Evidence on the relation between risk and time preferences and risky sex will help policymakers understand the connection between such behavior and welfare. Chapter 6 and 7 quantifies this relation. These chapters do not aim to give a proper estimate for the average level of risk and time preferences, but aim at finding the relation between sexual behavior, mortality and HIV infection risk, and testing. The contribution of these chapters is clear: knowledge about when and how people make risky choices like unprotected sex, helps developing interventions that mitigate this behavior. This could both help in prohibiting the further spread of HIV and limiting the economic consequences of the epidemic.

3.5 Savings and economic growth: empirics

This section provides a brief overview of the literature on the relation between HIV/AIDS and savings and economic growth (the lower box in Figure 3.1). Already in 1834 the importance of health and the uncertainty of human life for intertemporal choice was

recognized by John Rae in his publication of The Sociological Theory of Capital, where he was looking for the reason why wealth differed across nations. According to Rae, together with the amount of labor allocated to the production of capital, it was the psychological factor *"the effective desire of accumulation"* that determined a society's level of savings and investment and caused the difference in wealth. This effective desire of accumulation was encouraged by a bequest motive[17] and the propensity to exercise self-restraint, but was limited by the uncertainty of human life.

> *"When engaged in safe occupations, and living in healthy countries, men are much more apt to be frugal, than in unhealthy, or hazardous occupations, and in climates pernicious to human life"* (Rae 1834, p. 57)

Following Rae, mortality and illness risk induced by high HIV prevalence rates in society, would thus not only limit savings, investment, and the coping strategies of households, but also economic growth. In such a setting, countries are trapped in a vicious circle, since low economic growth caused by the epidemic leads to lower investments in human capital, more income equality, and a degenerated health infrastructure. This will in turn facilitate an increase in the spread of the epidemic.

There is no general agreement of opinion in the macro literature about the size of the economic impact of HIV/AIDS. While the effects in the field of social and demographic issues are often evident, economists have found mixed results when modeling the effects of HIV/AIDS on economic growth. The measured impact on economic growth ranges from no to negative effects (Bloom & Mahal (1995), Over (1992), Bonnel (2000), Arndt & Lewis (2000)) to large devastating effects (Bell et al. (2003)). However, there are also recent studies that even predict positive effects (Young, 2005). Different reasons might explain these equivocal results: First, it could be that none of the effects of the epidemic is yet large enough to influence economic growth. Second, Section 3.3 shows that HIV/AIDS is a slow-moving disease, which means that there is a lag between infection and AIDS sickness between 6 months and 10 years without treatment. This sickness-postponed effect might create a similar lag on the observability of the negative impact of HIV/AIDS in the empirical macro economic data. Especially early empirical studies might not yet capture all negative effects,

[17] Hurd (1989) and Gan et al. (2004) show that bequest motives are on average small and are mostly the result of uncertainty about the date of death.

such that larger effects will become visible over time, when the disease has destroyed some pillars of the economy like both physical and human capital, generating accumulated negative effects on future generations in terms of investments and human capital. Third, opposing effects, like anticipatory savings, may be present which are hard to catch at a macro level. Finally, Results are sensitive to the underlying assumptions of the models used. Amongst others it is often hypothesized that either HIV/AIDS will decrease (Over (1992)) or have no effect (Young, 2005) on savings, which biases the impact found on economic growth. This motivates more in-depth research on the influence on the main determinants of economic growth, like the impact on savings.

There is little empirical evidence on how savings is influenced by HIV/AIDS. The first empirical study on the macroeconomic effects of the HIV/AIDS epidemic on savings showed (using cross-country regressions over the period 1990 to 1996) that an increase in the HIV prevalence rate is associated with a reduction in the domestic saving rate in developing countries (Bonnel (2000)). Pradhan et al. (2006) show that HIV households in India have a lower level of savings: 18.1% had negative savings and 52% were zero savers. Furthermore, 43% had either borrowed money or liquidated assets for consumption. Empirical evidence seems to show a reduction in aggregate savings and savings among HIV-affected households due to HIV/AIDS, which would have serious impact on economic growth and widen the gap between western and developing world in terms of wealth even more.[18]

However, no study has analyzed the effects on savings behavior of not (yet) affected households. As illustrated in the simple lifecycle model, savings might as well as increase if agents consider future illness costs. The total effect on aggregate savings is thus not so clear-cut and should be tested empirically. Bonnel's empirical study does not provide a convincing answer, since it has been carried out with data from the 90s, when the epidemic was not as widespread and when the negative impact was not so evident for households as it currently is. If anticipatory behavior would develop as a response to HIV/AIDS, it could be the case that it can only be measured in the data recently.

[18] Africa's saving rate is already the lowest across all continents (Loayza et al. 2000).

3.6 Summary

Major differences of opinion are emerging in assessments of the economic impact of HIV/AIDS. It is, however, implausible that the epidemic would not affect the countries hardest hit. The value of the projections depends on how realistic the assumptions are underlying the different models. Savings and investment rates, and demographic projections are important elements in analyzing the impact of HIV/AIDS on economic growth. One explanation for the ambiguous results is that microeconomic changes might take place mitigating the effect at a macro level. Studying behavioral changes will therefore add to a better understanding of the welfare implications of the epidemic. Giving an overview of the current literature on HIV/AIDS and intertemporal choice, this chapter showed that little is known about these behavioral changes. This lack motivates the study in this thesis.

Households with AIDS sick, or HIV infected members are likely to change their intertemporal decisions different from households not (yet) affected. The current literature on HIV/AIDS and intertemporal choice, however, concentrates *either* on HIV as a health shock for *affected* households, or *either* as a disease that increases mortality risk for *all* households. The first line of literature, mostly poverty studies, points at the negative effects on income of AIDS affected households. They attribute the decline in available income for consumption to decreases in the number of hours worked, decreases in productivity or loss of job (the direct costs of illness) aggravated by increases in medical expenditures (the indirect costs of illness). The second stream of literature, the life-cycle studies, examines the effects of demographical changes through a decrease in lifetime, or changes in fertility. Both study consumption smoothing over lifetime, whereas the first mostly studies whether households are *able* to smooth consumption over their lifetime, the second strain of literature focuses more on *how* households smooth consumption over their lifetime. Although it is not so obvious what mechanism in intertemporal choice are actual present, the current literature on the economics of HIV/AIDS in general believes that savings will fall. However, empirical evidence is only obtained from data in an early stage of the epidemic, and theoretical models mainly consider mortality and do not consider anticipatory behavior induced by illness risk, that would enhance savings behavior.

Moreover, the extent to which perceptions of illness and mortality risk influence savings behavior depends on individuals' risk and time preferences. Large health shocks like HIV/AIDS influence these preferences in a way we yet do not know. In addition, sexual

behavior might be related to these preferences. The same risk and time preferences that mitigate savings or insurance behavior may also enhance risky sexual behavior. In this case, those who should anticipate illness costs are less likely to do so. This could not only create a serious problem for the coping abilities of affected households themselves, but causes negative externalities for society as a whole, which as a result has to care for these households.

This thesis adds to the current literature by simultaneously analyzing the effect of both illness and mortality risk on savings. The focus will be on the extent to which households anticipate illness risk and the related costs. This would give an indication of whether individuals are able to cope with the economic consequences once they become infected. Sub-optimal outcomes would plead for government interventions. Furthermore, this thesis attempts to clarify which groups are at risk of getting infected and to what extent these groups consider this risk in their economic decisions. Identifying the characteristics of different risk groups in society helps making HIV prevention and policymaking more tailor-made.

Part II: Theoretical Model

Chapter 4

The HIV Anticipatory Saving Motive: An Empirical Study in South Africa

4.1 Introduction

This chapter studies the effect of the HIV/AIDS epidemic on saving behavior. It addresses the following main questions of this thesis: Do individuals in societies afflicted by high HIV prevalence rates anticipate illness risk by individual saving? And is this effect larger than the decrease in savings caused by an increase in mortality risk?

To answer these questions, this chapter first introduces a simple two period life-cycle model with uncertain lifetime including perceived HIV contamination risk to illustrate the opposing effects of the HIV epidemic on individual saving behavior. It furthermore tests the predictions of the model with survey data obtained from an economic experiment with real monetary incentives performed in South Africa.

After its discovery in the late 1970s, the HIV/AIDS epidemic has rapidly developed into a widespread catastrophe. Over 25 million people have died of AIDS related diseases and 39.5 million people are living with HIV worldwide. High levels of adult prevalence rates are concentrated in Southern Africa with 18.8% in South Africa (UNAIDS, 2006). Because of the enormous size of the epidemic, main determinants of economic growth such as social capital, domestic savings, and human capital are expected to be affected. This would harm both social

and economic development. Many studies have been written on the effects of the HIV/AIDS epidemic on economic growth. However, as described in Chapter 3, little attention has thus far been given to the possible indirect economic behavioral effects of the HIV epidemic.

Once HIV infected, uninsured individuals face a long period of high expenses. The treatment of the disease requires additional expenses on healthy food and medical treatment. Steinberg et al. (2002), for example, show that in South Africa, AIDS affected households[1] spend more than a third of households' income on private medical care. At the same time, however, the disease lowered income with one third by a decrease in productivity or loss of job contributing to the financial burden.

While in developed countries families with sick members are able to access formal insurance markets, families in low-income countries must rely on informal mechanisms like participating in informal insurance groups (LeMay, 2007), or individual savings. LeMay shows that while 51% of the households in Cotonou (Benin) made expenses related to funerals and or illness during the last six months, only 18% of the surveyed observations were participating in some form of insurance, to cover these costs. Dercon & Krishnan (2000) show that although generally risk-sharing does occur within poor households in Ethiopia, full insurance against illness shocks does not. This might be due to the inability to predict actual illness risk and the associated costs. Pettifor et al. (2004), for instance, show that the youth in South Africa is indeed unable to correctly predict their HIV infection risk: only 21% of the HIV positive youths qualified their risk as high, whereas 62% reported to have a small HIV infection risk or no infection risk at all. Another explanation for underinsurance can be that households cannot afford full insurance and therefore save instead. Several impact studies like Booysen & Visser (2006) and Marzo (2004) show that HIV affected households fall into chronic poverty. This fact could stimulate unaffected households to anticipate the costs of illness by increasing savings.

It could thus be hypothesized that there is a positive relationship between HIV contamination risk and individual savings: individuals with a high contamination risk increase savings if they take the possible additional future costs caused by the illness into account when deciding how

[1] Their research population consisted of households that contained an AIDS-sick individual or households where someone had recently died of HIV/AIDS. Households with an HIV infected member that was not sick were not included in their sample.

much to save: the *HIV anticipatory saving hypothesis* as introduced in Chapter 1. On the other hand, being HIV infected significantly reduces life expectancy. Therefore, the probability of reaching the retirement age declines and agents will be less inclined to safe in order to have income when retired. Because the HIV epidemic causes both a decrease in life expectancy and an increase in the expectancy of near future illness, the overall effect of the HIV epidemic on individual saving behavior is ambiguous. (For a graphical illustration of these effects see Figures 3.3-3.4)

Although to the best of my knowledge the HIV anticipatory saving hypothesis has not been tested empirically, results from existing studies on the economics of HIV/AIDS do indirectly support the presence of the aforementioned opposing effects of the HIV epidemic on saving behavior. For example, Ferreira & Pessoa (2003), and Freire (2004) found a negative relationship between the HIV epidemic and saving behavior due to a fall in life expectancy. In his study about the macroeconomic effects of the HIV/AIDS epidemic using cross-country regressions, Bonnel (2000) found that the increase in the HIV prevalence rate from 1990 to 1996 reduced the savings rate in developing countries with -0.61 percentage points. Bonnel does however mention that in a well-established HIV epidemic savings could increase because households increase their savings to cover the expected higher medical costs if they view the risk of contracting AIDS related diseases as significant. Kochar (2004) found that higher expectations about future illness increased overall savings in Pakistani households, as predicted by the HIV anticipatory saving hypothesis. Pradhan et al. (2006) empirically show that HIV affected households[2] in India have lower levels of savings and almost half of these households had either borrowed money or liquidated assets for consumption.

This chapter presents a two-period lifetime optimization model that illustrates the opposing effects of HIV contamination risk on individual saving behavior. This model is based on the life-cycle theory (Ando & Modigliani, 1957), which posits that agents smooth consumption over their expected lifetime. The predictions of this model are tested using data from a laboratory experiment with real monetary incentives held among students in South Africa. The results indicate that both effects of the HIV epidemic (increased mortality and increased illness risk) indeed affect individual saving behavior as predicted by the simple model. The

[2] An HIV affected household in the most limited definition is a household that consists of at least one infected member. In the broadest definition every household in the hardest hit countries are HIV affected since the far-reaching consequences of the disease in society. In this thesis, by affected household, the limited definition is meant.

results thus plead for educating the population with correct and actual information on the magnitude of the disease and their actual lifetime HIV contamination risk. Providing this information will encourage savings and thus will reduce the welfare loss caused by the HIV epidemic.

The remainder of the chapter is organized as follows. The next section presents a simple two-period lifetime optimization model to illustrate the opposing effects of the HIV epidemic on individual saving behavior. Section 4.3 presents the experimental design followed by the experimental and estimation results in Section 4.4. Section 4.5 concludes.

4.2 Model

Consider a country where a large group of agents (normalized to one) optimizes consumption over two periods. When HIV starts to spread, it affects individual savings in the following way. First, the period over which agents optimize consumption declines because there is a fall in life expectancy. The model operationalizes this effect through an increase in perceived mortality risk and assumes that HIV contaminated agents will not enter the second period. Second, in a well-established HIV epidemic, agents will become aware of the HIV contamination risk they face. Agents understand the necessity of expensive medical treatment whenever they become HIV positive. This enhances savings, as predicted by the HIV anticipatory saving hypothesis.

Agents face a mortality risk q (i.e. with probability q agents do not enter the second period) and a certain risk p of contracting HIV. Agents optimize a simple logarithmic lifetime utility function and discount the future with discount factor $\delta = \frac{1}{1+\rho}$, where ρ is the discount rate. Agents only earn income w in the first period and earn interest rate r on their savings s in the second period. Savings of the deceased are distributed equally among their generation. Because agents are aware of the mortality risk of their generation, they consider the transfers of the deceased in the expected future income when optimizing their lifetime utility. The expected return on savings for agents that survive to the second period R is then defined as $R = \frac{1+r}{1-q}$. Agents can spend income on regular consumption (c_i) in both periods, but to keep things simple, it is assumed that only HIV contaminated agents are allowed to spend income on medical treatment, m_2 with price P_m. The parameter $\mu > 0$ is the marginal rate of substitution of regular and medical consumption. $\mu > 1$ shows the importance of medication

since it improves the quality of life. $\mu < 1$ might incorporate the disutility of taking medicines. See Problem (4.1) for the specific optimization problem.

$$\begin{aligned} \max_{c_1} U(c_1, c_{2G}, c_{2I}, m_2) &= \ln c_1 + (1-q)\delta[(1-p)\ln c_{2G} + p\ln c_{2I} + p\mu \ln m_2] \\ s.t.\ c_1 &= w - s \\ c_{2G} &= R(w - c_1) \\ c_{2I} &= R(w - c_1) - P_m m_2 \end{aligned} \tag{4.1}$$

where $c_1, c_{2G}, c_{2I} \geq 0, m_2 > 0.$

Taking the first order condition with respect to m_2, and backward substituting m_2^* into the maximization problem gives the optimal spending on regular and medical consumption[3]:

$$\begin{aligned} m_2^* &= \frac{R(w - c_1)\mu}{(1+\mu)P_m} \\ c_2^* &= \frac{w}{(1-q)\delta(1+p\mu)+1} \end{aligned} \tag{4.2}$$

Taking first derivatives with respect to q and p illustrates the opposite effects that the HIV epidemic has on individual savings. A marginal increase in mortality risk (q) negatively affects the amount of money agents save (see Equation (4.3)). However, a marginal increase in perceived HIV contraction risk (p) induces people to save more (consume less) in the first period (see Equation (4.4)). Note that for $0 < \mu \leq 1$ the marginal effect of an increase in p on savings in this model is smaller than the effect of a marginal increase in q. The more important medical consumption becomes compared to regular consumption the larger the relative effect of the HIV anticipatory saving motive compared to the mortality effect.

$$\frac{\partial s}{\partial q} = \frac{-w(1-p\mu)\delta}{[(1-q)\delta(1+p\mu)+1]^2} < 0 \tag{4.3}$$

$$\frac{\partial s}{\partial p} = \frac{w(1-q)\delta\mu}{[(1-q)\delta(1+p\mu)+1]^2} > 0 \tag{4.4}$$

[3] In this thesis medical consumption is a generic term for the additional consumption that is advised for HIV infected individuals. It includes e.g. medical care and treatment, healthy balanced food, supplements and immune boosters etc.

A limitation of this simple two-period model is that medical consumption does not prolong lifetime of HIV positive agents. Incorporating this effect would enhance the HIV anticipatory saving motive even further.

4.3 Experimental design

To test the predictions of the simple model, data is used from an economic experiment with real monetary incentives held among students in South Africa. This experiment builds on the discount rate experiments of Coller & Williams (1999) and Harrison et al. (2002). This section presents a short description of the experimental design. The appendix contains a more detailed description of the experiment including the experimental script, experimental tasks and the questionnaires.

Participants

A total of N = 213 students (114 males and 99 females) from a wide range of disciplines recruited at the Northwest University and the University of Pretoria in South Africa participated in the experiment. Students took part in 12 groups of around 20 respondents each. 82% of the respondents was black South African, 15% of the respondents was white, and the remaining 3% was colored. The average age of the white participants (15%) was 21.1 years (ranging from 19 till 24 years) whereas the average age of nonwhite (colored and black South African) participants was 22.9 years (ranging from 18 till 36 years). On average nonwhite students were poorer; the income distribution of nonwhite subjects is skewed to the left whereas the income distribution of white students is skewed to the right. Note that individuals' answers were based on perception[4] and might differ across both race groups. Therefore, the model includes a dummy for subjects who lived in an informal dwelling to capture the variation in socio-economic background. For more details on the characteristics of the participants, the reader is referred to Appendix A, Section A.5.

Procedure

At the start of the experiment, subjects received experimental instructions and the random devices used throughout the experiment (a bingo cage containing 100 balls, a 6-sided die, and a 10-sided die) were presented to subjects. In the instructions, it was emphasized that the experiment was anonymous (since it also involved sensitive questions related to health states)

[4] Subjects were asked to describe the income position of the household in which he lived at age 15. Classified by low, middle, and high.

and that there were no right or wrong answers. Both at the start and at the end of the experiment, participants were asked to fill out a short questionnaire. The first questionnaire concerned questions regarding socio-demographic characteristics such as age, gender, race etc., while the questionnaire at the end of the experiment concerned questions on financial instruments such as whether the participant did save or not and the current balance on participants' savings account and health related questions including questions on HIV status, perceived life expectancy and perceived HIV contamination risk.[5]

Table 4.1: Framing of the options (FED-treatment).

Decision	Option A To be paid in 1 month	Option B To be paid in 24 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 182.60	3%	(A) B
2	R 172	R 193.76	6%	(A) B
3	R 172	R 205.51	9%	(A) B
4	R 172	R 217.88	12%	(A) B
5	R 172	R 230.90	15%	(A) B
6	R 172	R 244.60	18%	(A) B
7	R 172	R 259.00	21%	(A) B
8	R 172	R 274.14	24%	(A) B
9	R 172	R 290.05	27%	A (B)
10	R 172	R 306.76	30%	A (B)
11	R 172	R 324.30	33%	A (B)
12	R 172	R 342.72	36%	A (B)
13	R 172	R 362.05	39%	A (B)
14	R 172	R 382.32	42%	A (B)
15	R 172	R 403.58	45%	A (B)
16	R 172	R 425.87	48%	A (B)
17	R 172	R 449.22	51%	A (B)
18	R 172	R 473.69	54%	A (B)
19	R 172	R 499.32	57%	A (B)
20	R 172	R 526.15	60%	A (B)

Stimuli

Because individual time preferences play a central role in saving behavior, the experiment measures individual discount rates. More specifically, the so-called *multiple price list design*

[5] Assuming that students truthfully reported on these perceptions, this is *exactly* the information that is needed for this study. Namely, these *perceptions* would influence economic behavior and not the *actual* individual life expectancy and HIV contamination risk.

(MPL) used by Harrison et al. (2002) is adjusted to the new setting. Participants were asked to make 20 outright choices between two options, called option A and option B, by simply encircling the preferred option on a sheet of paper. Both options yielded monetary prizes at specified dates. More specifically, option A yielded 172 Rand[6] in X months, while option B yielded an amount of Y Rand in Z months. The amount Y that option B yielded increased after each choice, starting at Y=172.43 Rand. Thus, option B became more and more attractive after each choice. In addition, participants received information about the annual interest rate that reflected the different prizes offered by option B, similar to Coller & Williams (1999) and Harrison et al. (2002). The options were presented in a table format similar to Table 4.1 reproduced on the previous page, as to make the task as easy and transparent as possible.

Motivating participants

In addition to a show-up fee of 30 Rand, performance-based real incentives are used to motivate participants based on the random lottery incentive system, the nowadays almost exclusively used incentive system for individual choice experiments (Holt & Laury, 2002). The main advantage of this system is that it avoids income effects such as Thaler & Johnson's (1990) house money effect, while it has been shown empirically that it is indeed incentive compatible, that is, agents do not interpret choice tasks rewarded with the random lottery incentive system as one grand overall lottery (Cubitt et al. 1998, Starmer & Sugden 1991). Since the task reported here was part of a larger experiment that all involved outright choices between two options, the probability that one of the chosen options would be played out for real was low. When selected for additional payment, subjects received a postdated check issued by Tilburg University, which could be cashed at any Standard Bank in South Africa any time after the specified date.

Treatments

There is empirical evidence that agents are more impatient about immediate delays than they are about future delays of the same length (Coller & Williams, 1999). Therefore, the timing of the prizes of both options varied between treatments. More specifically, in one treatment, called nFED (no Front-End-Delay) , option A always yielded an immediate prize while option B yielded a prize that would be paid in 23 months. In the other treatment, called FED (Front-

[6] 1 Rand equals about 0.14 USD in the year of the experiment.

End-Delay), option A always yielded a prize that would be paid in one month while option B yielded a prize that would be paid in 24 months.

4.4 Experimental and estimation results

4.4.1 Descriptive statistics

First of all, the results show that most students owned a savings account: 64.4% of the subjects reported to save and of these 52.6% reported to use informal saving methods. 82.0% reported to save on a formal account. Table 4.2 below shows how saving behavior differs among groups of subjects having different levels of perceived HIV contamination risk classified by no risk at all, small, moderate, high or HIV positive.

Table 4.2: Descriptive Statistics.[7]

Perceived HIV contamination risk	N (%)	Has medical insurance	Saves	Saver having savings account	Saver uses informal saving methods	Average amount of savings on scale 1-4	Average discount rate in %[8]
Not at all	54 (27.4%)	30.8%	65.4%	78.8%	55.9%	1.54	36.69
Small	83 (42.1%)	39.3%	61.4%	80.0%	51.9%	1.53	40.30
Moderate	28 (14.2%)	17.9%	60.7%	94.1%	70.6%	1.99	36.98
High	25 (12.7%)	28.0%	64.0%	73.3%	37.5%	2.19	43.92
HIV positive	23 (10.8%)	30.4%	78.3%	88.9%	44.4%	3.09	20.73
Total	213 (100%)	32.1%	64.4%	82.0%	52.6%	1.72	37.80

Subjects with a high perception of HIV contamination risk and HIV positive subjects appear to save more often compared to subjects that indicated to perceive their contamination risk as small or moderate. The amount of savings of HIV positive subjects and subjects with a high perception of HIV contamination risk is also significantly higher compared to the other groups (p-value[9]=0.03). Note however, that the group of subjects that indicated to perceive their contraction risk as high did report to use both informal and formal saving methods less

[7] For other characteristics of these groups, see Appendix B, Tables B4-B6.
[8] The discount used is the for mortality corrected discount rate as described in Chapter 7.
[9] Based on the Mann-Whitney test statistic (see for example Siegel & Castellan (1988).

frequently. The amount of savings among those who have a savings account however, is higher for this group and for the group of HIV positive respondents.

Life expectancy

Due to the HIV pandemic, life expectancy in South Africa has fallen from an average of 63.2 years to 42.7 years over the period 1990-2006 (see Section 2.3, Figure 2.9a). The reported life expectancy of the subjects varies from 25 to 120 years, with a mean of 72.38 years, which is substantially higher than the country average for people at age 20-24, which varies from 55 to 60 years (WHO, 2007). Subjects who indicated to be HIV positive reported a significantly lower life expectancy (59.1 years). Subjects who have a higher perceived HIV contraction risk reported an average life expectancy of 68.9 years, which is 4.55 years lower compared to subjects who indicated to have a lower risk.[10]

Perceived HIV contamination risk

The largest part of the subjects (80.9%) reported that HIV is the major cause of death in the North West province. Tuberculosis, a disease that is an important cause of death for many HIV infected patients, was seen as the second most important cause of death (60.3%). This shows some understanding of the HIV epidemic among the subjects. Subjects estimated their own risk of getting HIV infected, however, significantly lower than the risk of other students.

Although 57.2% of the nonwhite participants indicated that the HIV contamination risk of other students was high, only 15.9% of them perceived their own HIV contamination risk as high. None of the subjects reported that other subjects' HIV contamination risk was zero, whereas 27.5% indicated that their own HIV contamination risk was zero. 25.0% of the white participants reported to perceive others' HIV contamination risk as high, which is rather low compared to the 57.1% of the nonwhite participants. In general, these numbers again show a substantial awareness of HIV among subjects participating in the experiment.

The overall reported HIV prevalence rate among the sample was 10.9%. However, 4.7% of the subjects indicated to prefer not to report their test- or HIV status. This prevalence rate is comparable with the average HIV prevalence rate (9.9%) among the youth in the North West province (Pettifor et al., 2004), but the observed prevalence rate is high considering the fact

[10] The data furthermore show that the expected remaining lifetime is significantly decreasing in perceived risk exposure (corr=-0.32, p-value=0.0000), which conforms to expectations (see also Chapter 7, Section 7.4).

that among the students that are HIV positive only 10% is also aware of their status (Pettifor et al., 2004). Finally, 12.7% of the subjects indicated to have a high HIV contamination risk (see Table 4.2).

Discount rates

For each individual the individual discount rate is estimated by taking the average discount rate when a subject switched from choosing option A to option B. Thus, for example, from the choices made by the hypothetical subject whose choices are listed in the fifth column of Table 4.1, it can be inferred that the individual discount rate was equal to 25.5%. The resulting average discount rate over all sessions was 34.78%, which is substantially higher than an average discount rate of 24.2% obtained by Harrison et al. (2005a). This implies that the average South African is more impatient than the average Dane, which is perhaps not surprising if considering the economic differences between both countries. Compared to previous studies conducted in Western countries, a remarkable large proportion of subjects (42.6%) switched between the options more than once. If a participant switched more than once between options, then the discount rate was assumed to be equal to the midpoint of the interval over which the subject is indifferent.

The last column of Table 4.2 shows the average discount rates for each group of subjects. The observed discount rates of the first four categories are in agreement with 'common sense' observations. Among the subjects who considered themselves to have no HIV contamination risk at all, a relatively large percentage had the lowest discount rate, while, on the other hand, among the group of subjects that indicated to have a high contamination risk, a relatively large percentage had the highest discount rate. These findings are supported by Chesson et al. (2006) who show that unsafe sexual behavior is positively related to time preferences. Although Table 4.2 shows that subjects with a high-perceived risk exposure had a higher discount rate in the experiment, subjects who knew that they are HIV positive strikingly showed to be very patient. HIV infection thus seems to affect discount rates which may be explained by the HIV anticipatory saving hypothesis: HIV positive subjects might be aware of the additional spending they will face at the time they become ill, and are therefore prepared to delay consumption for a relatively long time. Chapter 7 analyses this remarkable finding.

The major drawback of the experimental method as often applied in Western countries is the debatable assumption that subjects are credit constrained. The financial data of the sample,

however, shows that this assumption among students in South Africa is less contentious. Subjects appear to have little arbitrage possibilities. Only 9.9% of the subjects reported to have a line of credit. Furthermore, only 15.9% reported to have a chance of at least 90% of being approved to obtain a loan if they would go to a bank.

4.4.2 Estimation Results

In order to test the hypothesis that there is a significant positive relationship between saving behavior and perceived HIV contamination risk and life expectancy as predicted by the life-savings model presented in Section 4.2, while controlling for individual differences between discount rates, marital status, gender, race, and the probability of obtaining a loan, a Simple Ordered Probit regression analysis is performed using the amount of savings on a 4-point scale as the dependent variable. To capture the variation in socio-economic background of the subjects, a dummy for subjects who lived in an informal dwelling is included in the regression. The results of this simple regression are reported in Table 4.3 below.

First of all, as can be seen in the table, students that reported to have a small probability of obtaining a loan significantly save less. This finding can be explained by the lack of income to be able to save and the related lack of collateral to obtain a loan. White students appear to significantly save more, possibly because they face less liquidity constraints.

Interestingly, there is a significant positive relationship between perceived HIV contamination risk and the amount of savings. This finding supports the HIV anticipatory saving hypothesis: If individuals consider the risk of contracting the virus and are aware of the related costs of being HIV infected, they save in order to anticipate these costs. The HIV positive subjects in the sample turn up to significantly save more as well. It should be noted here, that all the HIV positive subjects did not have AIDS yet. Although their spending pattern might already have changed (in order to delay the development of HIV into AIDS, infected individuals need things like balanced food, and medical care etc.), the most expensive period in which they are going to need extensive medical care and treatment is still to come. The saving effect for HIV positive students appear to be higher than those of students who perceive to be highly at risk, which can be explained by the fact that HIV positive students know for sure that the expensive period is looming ahead, while for the other group this is still just a risk.

In addition, Table 4.3 shows that students who have medical insurance, and therefore do not expect a dramatic increase in expenditures in case they become infected, save significantly less. Savings thus appears to be a substitute for medical insurance. This is not surprising in a country where many people do not have access to or cannot afford to have full medical insurance and as a result use savings as "insurance" for illness risk. The coefficient for a positive HIV status appears to be higher than that for the dummy for medical insurance. This indicates that medical insurance alone does not insure individuals for the full costs of illness. The fall in income and the need for a different consumption pattern seems to enhance savings as well.

Table 4.3: Estimation Results.

	Estimate	Standard Error
Discount Rate	0.001	0.007
Female	-0.070	0.267
White	1.140	0.377***
Urban	-0.345	0.291
Informal Dwelling	0.662	0.424
High Perceived HIV Contamination Risk	1.132	0.470**
HIV Positive	1.465	0.470***
Perceived Life Expectancy (years)	0.018	0.009**
Medical Insurance	-0.772	0.340**
Poor Chances Loan	-0.544	0.275**

Dependent variable: Amount of savings on a 4-point scale

Perceived life expectancy also significantly increases the amount of savings, which is in line with what life-cycle theory predicts. Thus, the empirical results clearly show that both opposing effects of HIV on individual saving behavior are present in the data. The overall effect of a fall in life expectancy with, e.g., 15 years on savings is less than the effect of having a high perception of HIV contamination risk or being HIV positive. This implies that individual savings among these participants in the experiment are positively affected by the HIV epidemic overall.

Although students that had lived in informal dwellings appear to save more (p-value=0.118), the other variables, gender, urban, and individuals' discount rate have an insignificant effect on the amount of money students save.

4.5 Conclusion

This chapter presents empirical evidence that suggests that the HIV epidemic has a positive effect on individual saving behavior, as predicted by the HIV anticipatory saving hypothesis. To illustrate this effect a simple lifecycle model is used that includes mortality risk and HIV contraction risk. The HIV anticipatory saving hypothesis posits that in a well-established HIV epidemic, agents consider the improved risk of contracting HIV and will save additionally to be able to make possible future expenses on medical treatment or to anticipate a decrease in income due to illness. Results from a regression model with data from a laboratory experiment using real monetary incentives in which is controlled for differences between individual discount rates, gender, race, way of life, the probability of obtaining a loan, and having medical insurance, show that there is a nonlinear relationship between HIV prevalence rate and saving behavior. The results show that HIV contamination risk and a positive HIV status positively affects savings. Furthermore, it is found that although individual saving is a substitute for medical insurance, the total increase in savings cannot be explained by the lack of medical insurance alone. Individuals seem to save on top of that for, e.g., lack of future income and additional illness-related expenditures not covered by medical insurance.

The HIV epidemic seriously affects economic growth by the erosion of social and human capital, and domestic savings. This study shows that it is also important that the population of countries hit by the HIV/AIDS epidemic knows its contamination risk from an economic point of view. Anticipatory saving improves the coping ability of HIV/AIDS infected households. Government inaction with respect to HIV knowledge will make the countries were the HIV epidemic is spreading worse off with respect to economic growth and welfare through the negative effects on savings caused by an increase in mortality risk. The results therefore plead for HIV prevention campaigns that encourage HIV testing and educate the population with correct and actual information on the magnitude of the disease and their actual lifetime HIV contamination risk. These policies will induce an anticipatory saving motive and thus positively affect social welfare and may therefore partly indemnify the disastrous effects that the HIV epidemic has on the hardest hit countries.

Chapter 5

HIV Contamination Risk, Savings and the Welfare Effects of Diagnostic Testing

5.1 Introduction

This chapter models the effect of the HIV/AIDS epidemic on aggregate savings and studies the welfare effects of diagnostic testing for HIV. It analyzes how the epidemic influences aggregate savings according to different stages of the epidemic. The epidemic decreases savings if especially young individuals are (perceived to be) affected by the virus, but may increase savings if individuals perceive a sizable probability of getting infected later. By the same token, the welfare effects of testing young individuals differs from the welfare effects of testing older individuals, since the savings responses to testing differ according to whether old or young individuals are tested. Chapter 3 showed that the HIV/AIDS epidemic affects every person in society. This chapter controls for the fact that it affects people with different test status differently. Obviously infected individuals are affected disproportionately: Since the incubation period of the virus is about 7-10 years (Bonnel, 2000), they face a long period of high expenses of specific food and medical costs. Persons tested HIV negative face relatively less uncertainty, compared to untested persons and can therefore allocate their incomes more efficiently.[1]

[1] The interested reader is referred to Chapter 2, Section 2.1 for a description of how consumption patterns are required to change over the course of HIV and to Chapter 3, Section 3.3 for a brief discussion on the empirical evidence of the influence of HIV infection on income and expenditures.

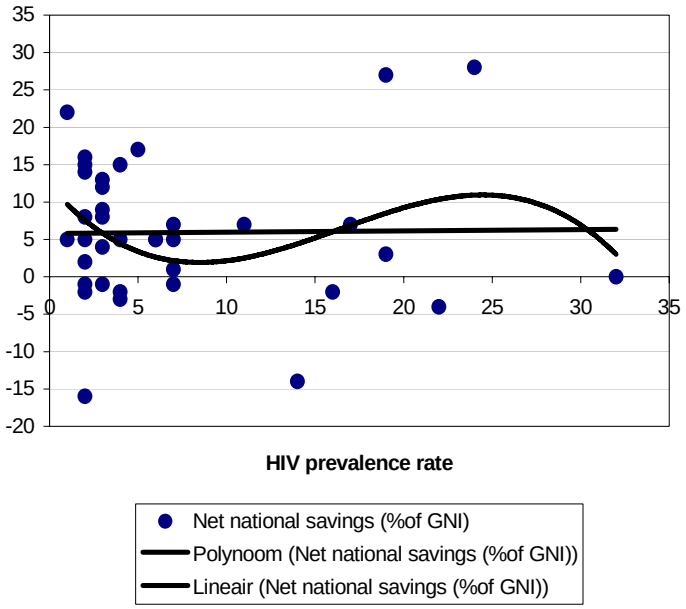
In many respects, the disease is of economic interest in developing countries where extensive social-insurance systems are lacking. In an influential paper, Young (2005) claims that the widespread infection, and its associated lower fertility, increases the scarcity of labor and, therefore, enhances future consumption possibilities. He assumed, however, a constant macro economic savings rate, implying that the stock of physical capital will not be affected in the long run. As described in Chapter 3 and 4, there are, however, many reasons to believe that societies adjust their savings pattern when a virus like HIV spreads, in short: the increase in medical expenditures due to infection forces households to reduce and finally exhaust their savings or assets (see Steinberg et al., 2002). In addition, savings for retirement are less necessary in societies where high mortality decreases the chances of getting old. As a counteracting force, however, savings may increase when the HIV epidemic spreads further. Since then individuals may anticipate that they may contract HIV in the future and are confronted with high costs of medical treatment by increasing their savings. Chapter 4 empirically showed that the latter effect dominates the negative effect of an increase in mortality if individuals perceive to be highly exposed to contracting the virus. Also Kochar (2004) confirmed the existence of this effect as he found that expectations of future illness increased overall savings in Pakistani households. However, these results do not tell much about the effect on aggregate savings, as perceptions of illness risk vary widely among individuals.

Most empirical studies to date found a negative effect of the HIV/AIDS epidemic on savings. Ferreire & Pessoa (2003) attributed this decline to a reduction in life expectancy.[2] Bonnel (2000), who estimated the macroeconomic effects of the HIV/AIDS epidemic using cross-country regressions, found that from 1990 to 1996 an increase in the HIV prevalence rate significantly reduced the change in the domestic saving rate in developing countries. However, he remarked that in a well-established epidemic savings could increase. In fact, recalculating his model including data from a more recent period, i.e. 1990-2004, provides no significant results anymore (see Annex A5.1). This calculation suggests that the effect of the epidemic on the domestic saving rate can be non-monotonic, and depends on the stage of the epidemic.

[2] Chapter 2, Section 2.3 shows that the reduction in life expectancy is substantial: over the period 1985-2005, the worst-hit countries saw the life expectancy fall by around 20 years.

Plotting actual HIV prevalence rates against net national savings in 2003 for a number of African countries indeed suggests that the relationship between HIV prevalence and savings indeed can be of a non-monotonic nature (see Figure 5.1).[3] In particular, an increasing prevalence rate might first decrease the national savings rate, then lead to an upswing in savings, and finally to a downfall again. Actually, the theoretical model presented below, predicts exactly such an evolution of savings over the spread of the virus.[4]

Figure 5.1: Net national savings (in %) and HIV prevalence rate (in %) in Africa (2003).



Source: World Development Indicators, 2006

This chapter employs a two-period lifetime optimization model to explain savings by a four-stage process partly supporting Bonnel's (2000) conjecture that savings are affected differently in the various stages of the epidemic. In the first distinguished stage, the disease is unknown. Some individuals die from the disease without knowing that AIDS killed them. These individuals are therefore not able to adapt saving behavior, so that aggregate savings are not affected. In the second stage of the epidemic, a group of young individuals falls ill, and get

[3] Note that excluding Swaziland, the data point on the far right, having a prevalence rate over 30%, changes this graph in a U-shaped curvature, showing a positive relation with net national savings for countries with a prevalence rate over 14%.

[4] Zhang et al. (2003) find a similar non-monotonic effect on savings due to increases in longevity based on a different model. In particular, starting at high mortality a mortality decline will first increase and later on decrease savings.

tested HIV positive. This group knows they contracted the virus and that they will not survive the first period. Being diagnosed HIV positive, they face a rise in expenditures on medical treatment[5] without having been able to save in advance for these costs. Because this group will not save for future consumption, a decrease in aggregate savings characterizes this second stage. In the third stage, the population becomes aware of the future risk they face of contracting the virus and will save for a possible future fall of income and increase in expenditures. In this stage, the number of young individuals with a positive HIV status is still small. Therefore, the increase in savings of the uninfected fraction of the population exceeds the decrease in savings of the HIV contaminated group. However, if the infection rate increases further, i.e. if many young individuals get infected, the decrease in savings by these diagnosed HIV infected individuals will exceed the increase in savings of the group that faces the risk of contracting HIV later in life and aggregate savings will fall again.

A second focus of the chapter is the effect of individual diagnostic testing for HIV. It is estimated that only 10% of the HIV-infected people are also aware of their status. Increasing status knowledge could therefore mitigate a further spread of HIV. Apart from, the effect on the HIV prevalence rate, testing can have important direct effects on individuals' welfare, which is crucial for decision making on the intensity of HIV-testing. This chapter analyzes these direct welfare effects of diagnostic HIV tests. The model assumes that individuals who are infected by the virus will derive less utility from the consumption of regular goods and derive more utility from the consumption of medical treatment than uninfected individuals. Furthermore, it assumes that being diagnosed HIV positive is necessary for getting the appropriate medical consumption.

Individuals can be tested in both periods of their life. Testing in period 1 obviously resolves the uncertainty in period 1, but not in period 2. Assume that testing only takes place at the start of each period. If the test result turns out to be positive, individuals are receiving a negative utility shock caused by a "fear-of-death" or "stigmatization" parameter. On the other hand, these individuals are better able to attain optimal (medical) consumption. On top of that, the individuals who receive a positive test in the first period of their life do not have to save for an uncertain chance of survival. Surprisingly, testing individuals who turn out to be

[5] Chapter 3 showed that medical costs are a significant part of HIV affected households' expenditures. Steinberg et al. (2002), for instance, finds that affected households in South Africa on average spend 34% on medical treatment.

HIV negative does not necessarily imply a positive welfare effect for these individuals. The reason is that although untested individuals will save less in the first period, they are still able to consume more in the second period of their lives. The latter is due to an (informal) "longevity" insurance system that is postulated for untested individuals[6], which redistributes savings from the diseased due to AIDS to the uninfected survivors. The positive effects of this redistributive insurance system have to be weighed against the negative utility effects of sub-optimal consumption choices if individuals are uncertain on being HIV infected or not.

Diagnostic HIV testing during the second period of individuals' life has, however, less ambiguous welfare effects. A higher frequency of testing during old age makes it more likely that an individual will be able to get the right medical consumption if he contracted the virus. This prospect makes it attractive to save more in order to be better prepared for possible higher medical consumption in the future. Due to more frequent future testing these savings have become more efficient in terms of individual utility, and so young individuals' expected lifetime utility will rise.

The remainder of the chapter is organized as follows. The next section presents the basic setup of the model. Section 5.3 derives the course of savings over the four distinguished stages of the epidemic. Section 5.4 evaluates the marginal effects of diagnostic testing for HIV status knowledge on social welfare and Section 5.5 concludes.

5.2 Model

This section describes the model assumptions and briefly defines the four stages of the epidemic. After presenting the broad outline of the model, the section turns to the specification issues.

5.2.1 Outline of the model

Consider a country where a large group of agents of the same age (their number normalized to one) optimizes consumption over two periods. In each period, agents face a certain probability, α_t^{act}, $(t = 1,\ 2)$, of contracting HIV, which might be different from their *perceived* probability of contracting the virus, α_t and a probability β_t of getting tested for

[6] Tested individuals are assumed not to participate. HIV positive individuals will not be alive in the period when the insurance pays out. HIV negative tested individuals are assumed to survive the first period and would thus got paid with certainty.

HIV. Assume that the perceived HIV contamination "risk" in each period, α_t, and the probability of knowing one's status in that period, β_t, is equal for all agents[7]. Agents die at the end of the period in which they are infected. Four different stages in the evolution of the epidemic are distinguished.

S*tage 0*

This is the benchmark case, in which HIV does not exist. Individuals optimize a simple logarithmic lifetime utility function containing regular and medical consumption. They save to smooth consumption over their lifetime.

Stage 1

In this stage, HIV starts to spread but the virus is yet unknown and therefore HIV testing cannot take place. A small fraction of the young population, $\alpha_1^{act} > 0$, is infected without this being perceived by the population, i.e. $\alpha_1 = 0$. In this initial phase of the disease, agents are not aware of their infection, and so they keep on behaving as in stage 0. Individual saving behavior is therefore not influenced, but after the first period of life, the savings of the deceased fall to the surviving part of the population and increases its consumption possibilities.

Stage 2

In stage 2, HIV is diagnosed for the first time. Although the prevalence rate α_1^{act} is still very small, the population has become aware of the contamination risk that they face, although not fully. In particular, agents underestimate the probability of contracting HIV and assume that the probability of infection when old is negligible, i.e. $\alpha_1^{act} > \alpha_1 > \alpha_2 \approx 0$.[8] Infected agents learn about their status only after a diagnostic HIV test.[9] Starting in this phase, testing takes place: a fraction β_1 of all young individuals is randomly selected to be tested. As a result, a fraction $\beta_1 \alpha_1^{act}$ of the young individuals will become aware of its positive status. On the other hand, a fraction $\beta_1(1-\alpha_1^{act})$ receives a negative test and is thus certain to reach the second

[7] Moreover it is assumed that $\alpha_1, \alpha_2, \beta_1,$ and β_2 are independent. Although these are strong assumptions, they are necessary to keep the model as simple as possible.

[8] Annex 5.2 includes the age profile of infection. The figure shows that infection on average takes place among young adults.

[9] Although there is some controversy on the validity of HIV testing, in this dissertation it is assumed that a diagnostic HIV test exist and that it is 100% accurate in diagnosing HIV.

period.[10] In this phase of the disease, where HIV becomes visible in society, individual savings are negatively affected in the following two ways. First, the fraction $\beta_1\alpha_1^{act}$ of young individuals who know they are infected will no longer save.[11] Second, those young agents who are not tested, perceive to have a lower life expectancy as they now expect to have a lower probability (i.e. $1-\alpha_1$ instead of 1) of reaching the second period.[12] As a result, their savings will decrease.

Stage 3 and 4

In stage 3, HIV develops into a serious epidemic. Agents who have been tested negative or who have not been tested at all in the first period, take account of the higher probability of being infected in the second period, i.e. $\alpha_2 > 0$. In particular, if agents in the second period get a positive test result, they will want to buy more medical consumption to fight the consequences of the disease. Therefore, the higher-perceived value of α_2 will engender higher savings by the agents in this group. On the other hand, as the group of positive-tested individuals in the first period increases as well due to the spread of the disease, the group who does not save at all increases in size. In stage 3, the former effect on savings dominates the latter effect, i.e. aggregate savings increase. Stage 4 is defined by the property that the effect of the decrease in savings of the HIV positive agents in period 1 dominates the effect of the increase in savings by the individuals who have a chance of reaching the second period. It is assumed that in stages 3 and 4 perceived and actual contamination rates converge, i.e. $\alpha_1 \to \alpha_1^{act}$ and $\alpha_2 \to \alpha_2^{act}$.

5.2.2 Specification of the model

Expected utility of a young individual who lives in a phase *j* of the epidemic depends on whether he is tested or not, and if tested, on the outcome of the test. The utility of an individual tested HIV positive is:

$$u_1^j(c_1^j, m_1^j) = \xi_i \ln c_1^j + \mu_i \ln m_1^j + z_{i1} \qquad (5.1)$$

where c (m) represents regular (medical) consumption with prices equal to 1 and p_m respectively. ξ and μ are preference parameters for regular and medical consumption

[10] For simplicity, abstract from other sources of mortality in the first period of life.
[11] Individuals that are infected in the first period are assumed not to survive to the next period.
[12] The model assumes that irrespectively of lifestyle, individuals have an equal probability α_i of being infected.

respectively. The subscript on these parameters indicates that the utility of both regular and medical consumption depends on the health position of the individual. In particular, if the individual is HIV infected, indicated by *i*, he derives less utility from regular consumption than if he is healthy, indicated by *h*, but more utility from medical consumption, i.e. $\xi_h > \xi_i$ and $\mu_h < \mu_i$. Consequently, if agents get a positive test, they will substitute medical consumption for regular consumption. A negative constant z_j is added to indicate that the positive-tested individual suffers from knowing to die prematurely and/or being stigmatized.[13] Expected utility of a negative-tested individual is:

$$u^j(c_1^j, c_2^j, m_1^j, m_2^j) = \xi_h \ln c_1^j + \mu_h \ln m_1^j + \delta u_2^j(c_2^j, m_2^j) \tag{5.2}$$

where $\delta > 0$ is the discount factor and $u_2^j(c_2^j, m_2^j)$ stands for the expected second-period utility. Untested individuals in a certain period can be HIV-positive nevertheless. However, the model implicitly assumes that these individuals do not have access to the kind of medical consumption that is suited for HIV patients. Thus, even if untested individuals learn to have been infected, they will not be able to consume more medical care in that period. This assumption is built into the model directly since untested but infected individual has to takes μ_h as the relevant parameter in the utility function ex ante, although ex post μ_i determines the realized utility. The expected utility of untested individuals in period 1 is specified in Equation (5.3).

$$\begin{aligned} u^j(c_1^j, c_2^j, m_1^j, m_2^j) &= \xi_1 \ln c_1^j + \mu_h \ln m_1^j + (1-\alpha_1)\delta u_2^j(c_2^j, m_2^j) \\ u_2^j(c_2^j, m_2^j) &= \alpha_2\beta_2(\xi_i \ln c_2^j + \mu_i \ln m_2^j + z_2) + \alpha_2(1-\beta_2)(\xi_i \ln c_2^j + \mu_h \ln m_2^j) \\ &\quad +(1-\alpha_2)(\xi_h \ln c_2^j + \mu_h \ln m_2^j) \end{aligned} \tag{5.3}$$

where $\xi_t \equiv \alpha_t \xi_i + (1-\alpha_t)\xi_h$. The model assumes that untested individuals in the first period take part in a mutual insurance system in which the savings of those who decease in the period are distributed among the untested survivors.

[13] Note, however, that z_j can be a positive constant as well. A participant of the survey in South Africa, for instance, said: "*I have more future now after being tested HIV positive*", when he was explaining his increased positive attitude towards live.

Agents only earn an income w in the first period and earn interest rate r on their savings. Given this and the specified utility function, the individual and aggregate savings for all distinguished stages of the spread of the virus can be derived.

5.3 The evolution of savings

Stage 0: $\alpha_j^{act} = \alpha_j = 0; \beta_j = 0,\ j = 1,2$

If HIV prevalence is zero, individual and aggregate savings are readily found to be equal to:

$$S^0 = s^0 = \frac{\delta}{1+\delta} w \tag{5.4}$$

where aggregate savings, S^0, equals individual savings, s^0, as the size of a generation has been normalized to one.

Stage I: $\alpha_1^{act} > \alpha_1 = 0; \alpha_2^{act} = \alpha_2 = 0; \beta_j = 0,\ j = 1,\ 2$

HIV unexpectedly shows up. However, as the disease cannot be diagnosed yet, saving behavior does not change, the only difference with stage 0 being that the total savings of the deceased, $\alpha_1^{act} s^I$, will be distributed among the $(1-\alpha_1^{act})$ survivors.

Stage II: $\alpha_1^{act} > \alpha_1 > \alpha_2 \approx 0; \beta_1 > 0; \beta_2 = 0$

In this period, HIV tests for young individuals become available, and a percentage β_1 of young individuals will be tested. Three different groups become relevant for saving behavior. First, a fraction $\beta_1 \alpha_1^{act}$ of agents, to be indicated by group G1, who have been tested positive, will not save, as in they will not enter the second period. Second, a fraction $\beta_1(1-\alpha_1^{act})$, group G2, is sure to reach the second period and will save $s^{II}(G2) = \frac{\delta w}{1+\delta}$. Third, the $1-\beta_1$ untested agents, indicated as groups G3 and G4, perceive to have a chance of $1-\alpha_1$ of reaching the second period. Groups G3 and G4 consist of agents that, respectively, do carry and do not carry the virus, but are unaware of their HIV status. Only ex post, can the untested individuals be allocated between groups G3 and G4. Consequently, they have equal ex ante optimal savings. Maximizing expected utility for the groups G3 and G4 yields their individual savings:[14]

[14] Note that the model assumes an equal discount factor for groups 2, 3 and 4. This assumption is supported by the empirical evidence of the survey conducted among students in South Africa (see Appendix A for a detailed

$$s^{II}(G3;G4) = \frac{\delta(1-\alpha_1)}{1+\delta(1-\alpha_1)} w \tag{5.5}$$

Aggregating over the groups gives the total savings in stage II of the epidemic:

$$S^{II} = \beta_1(1-\alpha_1^{act})\frac{\delta}{1+\delta} w + (1-\beta_1)\frac{\delta(1-\alpha_1)}{1+\delta(1-\alpha_1)} w \tag{5.6}$$

As can be readily seen from Equation (5.4) and (5.6), it holds that $S^{II} < S^0$.

Stage III: $\alpha_1^{act} \geq \alpha_1 \geq \alpha_2 > 0, \beta_j > 0, j = 1, 2$

This third phase distinguishes itself from stage II by the fact that young individuals have become aware of the HIV contamination risk they face in *both* periods of their life. Individuals know that in period 2 they can be tested with a probability β_2 and they understand that a positive HIV status brings along a decline in utility of regular consumption and that medical treatment improves the way of life. This will affect savings of the groups distinguished above.

The young agents that are tested HIV positive (group G1), behave the same as in stage 2 and thus will not save. The agents in group G2, who are sure to reach the second period, and the untested agents in group G3 and G4, who perceive to have a probability of $1-\alpha_1$ of reaching the second period, do change their savings behavior. Since they are now aware of the possibility to get positively tested in the second period of their life, they will save more to be able to better cope with the consequences of HIV infection. These 'anticipatory' savings will initially be larger than the decrease in savings due to the risk of not reaching the second period.

For the $\beta_1(1-\alpha_1^{act})$ agents who have been tested negative in the first period (group G2), savings equal:

$$s^{III}(G2) = \frac{\delta\chi}{\delta\chi + \xi_h + \mu_h} w \tag{5.7}$$

description of the study). Based on the estimations of the corrected discount rates as described in Chapter 7, the discount rates do not statistically differ between those reported to be tested HIV negative and those that report to have never been tested (p-value=0.28).

where $\chi \equiv \xi_h + \mu_h + \alpha_2(\xi_i - \xi_h) + \beta_2\alpha_2(\mu_i - \mu_h)$. Comparing the savings of group G2 in stage II and stage III, it can easily be seen that savings is higher in stage III, i.e. $s^{III}(G2) > s^{II}(G2)$ if and only if the following condition holds

$$\xi_i - \xi_h + \beta_2(\mu_i - \mu_h) > 0 \tag{5.8}$$

Condition (5.8) implies that the relative decrease in utility of regular consumption when HIV infected is smaller than the relative increase in utility of medical consumption weighted for the fact that individuals can also make use of medical consumption. Thus, in a well established epidemic savings of HIV negative tested individuals (G2) are enhanced, whenever medical consumption is relatively important compared to regular consumption in case tested HIV positive, under the condition that testing in the second period takes place at a certain level. The further analyses assume that this condition holds.

Agents that are not tested in the first period (group G3 and G4), save for the second period even though some of them will never enter this period. Their savings equal:

$$s^{III}(G3;G4) = \frac{(1-\alpha_1)\delta\chi}{(1-\alpha_1)\delta\chi + \xi_1 + \mu_h} w \tag{5.9}$$

Comparing $s^{III}(G3;G4)$ with $s^{II}(G3;G4)$ in Equation (5.5) shows that stage III will generate more savings for groups G3 and G4 than stage 2. Consequently, aggregate savings in stage III, specified in Equation (5.10) is higher than in stage II.

$$S^{III} = \beta_1(1-\alpha_1^{aat})s^{III}(G2) + (1-\beta_1)s^{III}(G3;G4) \tag{5.10}$$

Aggregate savings in stage III may even rise to a level higher than in the situation without HIV, i.e. $S^{III} > S^0$. Whether this inequality actually holds depends on the parameters of the model, the degree of testing in the first period, β_1, being one of the critical parameters. In general, for any given probability of first-period testing, i.e., $0 \le \beta_1 \le 1$, $S^{III} > S^0$ will hold if $\alpha_2 \ge f(\beta_1)$. If testing increases, the number of agents who know for sure not to survive the first period will increase for a given first-period mortality rate. Thus, the best condition for an

increase in savings above the benchmark level is when $\beta_1 = 0$. Savings is least likely to increase with $\beta_1 = 1$, when all young individuals know their HIV status. Considering both cases in turn provides an idea when savings will increase. If $\beta_1 = 0$ it is straightforward to derive that $S^{III} > S^0$ if:

$$\alpha_2 \geq \frac{\alpha_1}{1-\alpha_1} \frac{\xi_i + \mu_h}{\xi_i - \xi_h + \beta_2(\mu_i - \mu_h)} \equiv f(0) \tag{5.11}$$

Obviously, condition (5.11) can only hold if the perceived mortality rate in the first period α_1 is small enough.

The other extreme case is where $\beta_1 = 1$, i.e. where complete testing takes place in the first period. This takes away all uncertainty on the probability of dying in the first period, and only those who are sure to survive the first period will keep on saving. In this case, savings will increase above the benchmark level, if:

$$\alpha_2 \geq \frac{\alpha_1^{act}(1+\delta)}{1-\alpha_1^{act}(1+\delta)} \frac{\xi_h + \mu_h}{\xi_i - \xi_h + \beta_2(\mu_i - \mu_h)} \equiv f(1) \tag{5.12}$$

According to Equations (5.11) and (5.12) savings rise to a level above the benchmark level if the perceived and actual first-period mortality rates are small enough, compared to the second-period contamination rate. This makes intuitive sense as the spread of the virus among young individuals decreases their savings, while the expected spread of the virus among old individuals increases savings. So, for a given testing rate β_1 and with a relatively small-perceived infection rate α_1 compared to α_2, aggregate savings may increase.

Stage IV

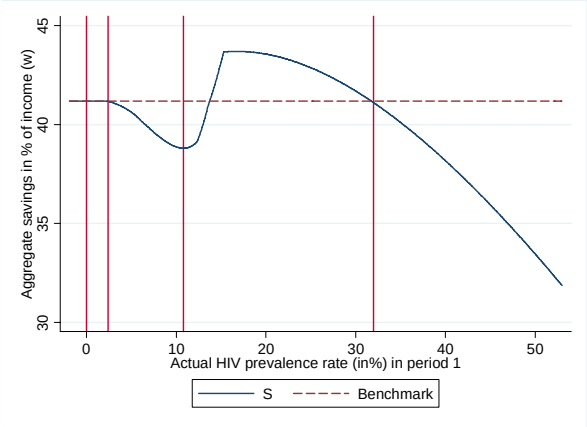
If the actual number of HIV-infected individuals, α_1^{act}, keeps rising, the number of individuals in group G2 will decline. Although individual savings will remain unchanged, the group composition changes, in this case implying that aggregate savings will eventually decrease. Moreover, notice from Equation (5.9) that with an increase in the perceived contamination rate when young, α_1, individual savings of untested individuals will decrease as well. In fact, if both α_1 and α_2 increase by the same proportion, then it is easy to see from Equation (5.9)

that the savings-decreasing effect of the current rate α_1 will eventually dominate the savings-increasing effect. In stage IV, prevalence rates are at such levels that the savings-decrease effect dominates.

Figure 5.2 gives an example of the development of savings over the evolution of HIV[15]. The solid line represents the four different stages of the epidemic as specified by the model above. The horizontal part of the line shows the situation without HIV, where agents save a certain amount for future consumption (stage 0). Then stage I arrives where the disease overtakes some agents. Since the presence of the disease is still unknown, the infected agents are not aware of their illness. As a result, they die prematurely, making it impossible for them to optimally use their lifetime resources. Their redundant or unused savings for the second period are transferred to the survivors. In stage II, testing makes it possible for HIV infected agents to know they will not survive the first period. This enables them to optimize lifetime utility by spending all income in the first period. The fall in aggregate savings represents the decline in savings of this particular group of agents. Next, a stage sets in where agents become (gradually) aware of the pervasiveness of the possibility of infection over their whole life. As a result, those who have a chance of surviving the first period will save more to take account of the additional costs in case of being contaminated by the virus in the second period of their life. In this stage, the savings-decreasing effect of higher young-age mortality (i.e. an increase in actual, α_1^{act}, and expected mortality, α_1 is counteracted by the savings-increasing effect of higher expected old-age mortality, α_2, so that savings increase above the benchmark level. In the figure, this occurs for values of $0.14 \leq \alpha_1^{act} \leq 0.32$. If the spread of HIV continues and manifests itself via an increase of the prevalence rates in both periods, the savings-decreasing effect of young-age mortality will be dominant and savings start to decrease. In Figure 5.2, the decline of savings (compared to the benchmark) sets in after the HIV prevalence rate reaches the value of 32%.

[15] The drawing in Figure 5.2 assumes that populations gradually become aware of the HIV contamination risk they face. Agents first underestimate the actual HIV contamination risk, but when the disease spreads, actual and perceived HIV contamination risks converge. The calculations in Figure 2 assumed this convergence process over time to be specified by $\alpha_1(t) = \lambda\alpha_1^{act}(t) + (1-\lambda)\alpha_1(t-1)$. For α_2, an analogous specification holds.

Figure 5.2: The different stages of aggregate savings due to the spread of HIV



5.4. The social-welfare effects of testing for HIV

One of the important policy decisions in countries affected by HIV is the frequency of testing, in the model indicated by β_1 for young and by β_2 for old agents, respectively. The question addressed here is whether intensifying testing directly increases social welfare. That is, the analysis abstracts from the (possible) long-run effect of testing on the HIV prevalence rate and analyzes the effect of HIV testing on social welfare, using *ex post* individual utility as the relevant criterion.

Assume that implementing a test does not involve any cost. Testing when young resolves the uncertainty on the true values of the parameters in the utility function, making it possible to purchase the utility-maximizing ratio of regular and medical consumption. When tested positive, individuals will no longer have to save for an uncertain future, as they know for sure to die young, i.e. before the second period. However, if the utility function contains a 'fear-of-dying' or 'stigma' parameter, agents experience a negative utility shock if they are actually diagnosed HIV positive and realize that they will die prematurely. On the other hand, if individuals get a negative test result they will save more, as they will reach the second period with certainty. These individuals however, can no longer take part in the longevity insurance scheme, which means that, after surviving the first period, they will no longer get a transfer payment from their deceased contemporaries.

Increasing the frequency of testing during older age does not take away the uncertainty of later infection at the time when the saving decision is made. It does increase, however, the

probability that an individual can consume the right amount of medical consumption when he turns out to be infected later in life. The prospect of utility maximizing consumption later in life incites individuals to save more. In this case, this appears to be welfare increasing.

5.4.1 Testing young individuals (β_1)

We use *ex post* individual utility as the criterion to evaluate the effects of testing on social welfare. Individuals make their saving decisions at the beginning of the first period of life, however. Social welfare is then defined by:

$$W(\beta_1,\beta_2)=\beta_1[\alpha_1^{act}U(G1)+(1-\alpha_1^{act})U(G2)]+(1-\beta_1)[\alpha_1^{act}U(G3)+(1-\alpha_1^{act})U(G4)] \quad (5.13)$$

In Equation (5.13), $U(Gi),(i=1,..,4)$ indicates *ex post* utility of young agents distinguished by both their HIV status and their test status in the first period. In particular, as noted before, the groups $G1$ and $G2$ are composed of the individuals who have been tested HIV positive and negative, respectively. The groups $G3$ and $G4$ consist of the individuals who have not been tested in the first period. In the first period, they may turn out be HIV infected, $G3$, or to be healthy, $G4$. The marginal effect of first-period testing on social welfare obviously depends on the utility difference between tested and untested individuals, as specified in Equation (5.14):

$$\frac{\partial W(\beta_1,\beta_2)}{\partial \beta_1}=\alpha_1^{act}\big(U(G1)-U(G3)\big)+(1-\alpha_1^{act})\big(U(G2)-U(G4)\big) \quad (5.14)$$

It is straightforward to derive that for those infected with HIV the utility difference $U(G1)-U(G3)$ can be written as:

$$\begin{aligned} U(G1)-U(G3)=(\xi_i+\mu_i)\ln\frac{\xi_1+\mu_h+\delta(1-\alpha_1)\chi}{\xi_1+\mu_h}+ \\ \left[\xi_i\ln\frac{\xi_i}{\xi_1}+\mu_i\ln\frac{\mu_i}{\mu_h}+(\xi_i+\mu_i)\ln(\frac{\xi_1+\mu_h}{\xi_i+\mu_i})\right]+\tilde{\varepsilon}_1 \end{aligned} \quad (5.15)$$

The first term on the right-hand side of Equation (5.15) is the utility gain from lower savings. The term in brackets represents the utility gain due to consuming the optimal proportion of regular and medical consumption. The last term is the "stigma" parameter. Obviously, for the

agents with a positive HIV-status testing is only utility improving, i.e. $U(G1)-U(G3)>0$, if the "stigma" parameter is small enough. In that case, the utility improving effects of getting the appropriate medical consumption and the elimination of excess savings dominate the stigma effect.

Tested negatively in the first period, resolves the uncertainty in this period, but not in the second. Again, the utility improving effect of the revelation of their status is that they are able to purchase the optimal ratio of regular and medical consumption goods (the term in brackets in Equation (5.16)). On the other hand, if their status is revealed, they can no longer take part in the insurance system that insures them against longevity risk. As a result, the return on their savings will be lower. The effect of testing for this group can be written as:

$$U(G2)-U(G4)=(\xi_h+\mu_h)\ln\frac{w-s(G2)}{w-s(G3;G4)}+ \\ [\alpha_2^{act}\delta(\xi_i+\mu_i)+(1-\alpha_2^{act})\delta(\xi_h+\mu_h)]\ln\frac{s(G2)}{s(G4)}+ \\ \left[\xi_h\ln\frac{\xi_h}{\xi_1}+(\xi_h+\mu_h)\ln\frac{\xi_1+\mu_h}{\xi_h+\mu_h}\right] \tag{5.16}$$

where $s(G4)$ represents the savings of individuals from group $G4$, including the transfer from the deceased individuals in group $G3$, i.e. $s(G4)=\frac{s(G3;G4)}{1-\alpha_1^{act}}$.

The first term on the right-hand side of Equation (5.16) is negative due to the fact that savings will be higher if the individuals are certain to reach the second period, i.e. $s(G2)>s(G3;G4)$. The next term represents the effect on disposable income in the second period, in case the individual is infected or not infected, respectively. Strikingly, although untested individuals save less than individuals tested HIV negative, if they survive, their disposable income in the second period is higher, i.e. $s(G4)>s(G2)$. This is due to the transfers they receive from the group of deceased individuals, $G3$.

In both periods, individuals tested HIV negative thus appear to have a lower disposable income compared to individuals who turn out to be HIV negative without having been tested. Obviously the last term, representing the utility effect of getting the 'right' consumption ratio

when tested HIV negative, is positive again. So, for the group if HIV-negative individuals, testing generates a positive *ex post* welfare effect if this consumption-ratio effect is larger than the disposable income effect.

Notice that when the virus is not widespread yet, i.e. when α_1^{act} is small, more testing might turn out to produce a negative welfare effect, due to the decrease in disposable income of tested individuals. If the virus spreads, the first utility difference in Equation (5.16) will become relatively more important and the welfare gains of testing then depends largely on the relative strength of the fear-of-dying parameter.

5.4.2 Testing old individuals (β_2)

Consider now a change of testing frequency in period 2. Changing the frequency of testing will cause all individuals who were tested HIV negative in the first period, and those who were not tested at all, to increase their savings. For these groups the increase in savings is motivated by the expected increase in medical consumption when tested HIV positive in the second period of life. A second effect of future testing is the increased probability of being able to consume the right proportion of regular and medical consumption. Notice, however, that *ex post* group $G3$ will not enjoy this positive effect of testing because they die prematurely. For group $G2$ the utilitarian *ex-post* social-welfare effects of a change in β_2 is calculated as:

$$\begin{aligned}\frac{\partial U(G2)}{\partial \beta_2} = {} & (\xi_h + \mu_h + \delta\chi)\alpha_2(1-\beta_2)(\mu_i - \mu_h)\frac{w}{\chi}\frac{\partial S(G2)}{\partial \beta_2} + \\ & \delta\alpha_2\left[\xi_i \ln\frac{\xi_i}{\xi_2} + \mu_i \ln\frac{\mu_i}{\mu_h} + (\xi_i + \mu_i)\ln\frac{\xi_2 + \mu_h}{\xi_i + \mu_i}\right] + \\ & \delta(1-\alpha_2)\left[\xi_h \ln\frac{\xi_h}{\xi_2} + (\xi_h + \mu_h)\ln\frac{\xi_2 + \mu_h}{\xi_h + \mu_h}\right] - \alpha_2\delta\chi_2\end{aligned} \tag{5.17}$$

where the terms in brackets are again the utility effects of being able to consume the optimal ratio of goods after having received a positive or a negative test, respectively. Obviously, these terms are positive. The first term indicates the effect of the additional savings on utility for group $G2$. It can be derived that $\partial S(G2)/\partial\beta_2 > 0$ under the assumption that medical consumption generates higher utility if individuals are HIV infected, i.e., $\mu_i - \mu_h > 0$. Given

this result, from the first term on the right-hand side of Equation (5.17) it can be inferred that the additional savings engendered by a higher testing frequency β_2 leads to a gain in *ex-post* utility. Apparently, by saving more and having more disposable income for financing the higher expected medical consumption, individual utility increase. The only negative effect is the negative utility shock $-\alpha_2\delta\tilde{\chi}_2$ produced by the information of being infected, i.e., the stigma effect. Equation (5.18) specifies the *ex-post* social-welfare effects of a change in β_2 for group $G4$.

$$\begin{aligned}\frac{\partial U(G4)}{\partial \beta_2} = {} & (\xi_h + \mu_h + \delta(1-\alpha_1)\chi)\cdot \\ & \left[-\frac{\xi_h + \mu_h}{\xi_1 + \mu_h} + \frac{\alpha_2(\xi_i + \mu_i) + (1-\alpha_2)(\xi_h + \mu_h)}{(1-\alpha_1)\chi}\right]\frac{\partial S(G3;G4)}{w\partial \beta_2} + \\ & \delta\alpha_2\left[\xi_i \ln\frac{\xi_i}{\xi_2} + \mu_i \ln\frac{\mu_i}{\mu_h} + (\xi_i + \mu_i)\ln\frac{\xi_2 + \mu_h}{\xi_i + \mu_i}\right] + \\ & \delta(1-\alpha_2)\left[\xi_h \ln\frac{\xi_h}{\xi_2} + (\xi_h + \mu_h)\ln\frac{\xi_2 + \mu_h}{\xi_h + \mu_h}\right] - \alpha_2\delta\tilde{\chi}_2\end{aligned} \tag{5.18}$$

Not surprisingly the effects that can be distinguished are qualitatively the same as with group $G2$, i.e. a savings effect (the first term), a consumption effect (the second and third term) and a direct negative utility shock (the last term). It is fairly easy to prove that the effect of higher savings on utility is again positive. Moreover, the two terms in Equation (5.18) representing the ability to purchase the correct consumption ratio represent a positive effect as well. Thus, also for this group testing implies a trade-off between the 'stigma' and the opportunity of optimal consumption according to their medical condition.

Finally, untested individuals who do not survive the first period, i.e. group $G3$, will save more if the frequency of future testing increases. However, they will not experience the higher utility of consumption in the second period. Their increased savings fall due to the surviving members of the untested group, i.e., group $G4$. Therefore, intensifying testing will *ex post* have a negative effect on utility for group $G3$. Notice, however, that this group diminishes in size if the frequency of testing in the first period rises.

5.5 Conclusion

This chapter employed a two-period lifetime optimization model to explain saving by a four-stage non-monotonic process partly supporting Bonnel's (2000) conjecture that the HIV affects saving differently in the various stages of the epidemic. The chapter in particular considered two issues: First, how aggregate private household saving reacts to changes in HIV incidence in the specified four stages of the epidemic. Second, the chapter analyzed the social-welfare effects of diagnostic testing for HIV. The period of life in which HIV strikes, appears to be an important determinant for both issues.

Regarding saving, if individuals perceive that HIV might predominantly affect them at young ages, they will lower their savings for old age since their expected lifetime is shortened. However, if individuals start taking into account the fact that HIV might also strike them at an older age, they will start to save more in order to be able to purchase the appropriate medical treatment later in life. If the HIV contamination rate among the young is not too large, the 'anticipatory-savings effect' will be the dominant force, and lead to an increase in aggregate savings. Aggregate savings might even temporarily rise to a level that is above the benchmark case level without HIV. If this occurs, the general-equilibrium effects described by Young (2005), which leads to higher wages and higher welfare for future generations, can be strengthened if the mortality rate among the young is limited. If the spread of HIV among the young intensifies, the effect of decreasing old-age savings dominates the HIV anticipatory-saving effect in the end. Then the 'gift of the dying' (in the words of Young, 2005) no longer consists of a larger capital stock associated with higher savings, but an increasing scarcity of labor.

Regarding the welfare effects of intensifying HIV testing, the results largely depend on whether testing takes place when individuals are young or old. When individuals are young, testing resolves (at least partly) the uncertainty of surviving the first period of life. For those individuals tested positive, there is no longer a need to save for old-age consumption. These individuals are instead able to focus on getting the right medical treatment and thus reallocate their disposable income from non-medical to medical consumption. This is obviously utility enhancing whenever the disutility of knowing to die prematurely is relatively low. For HIV negative individuals, the effects of more frequent testing are not that clear cut. When tested negative, they can benefit from consuming the correct mix of regular and medical consumption in the first period. However, total consumption in this period will be lower as

they are certain to survive the first period and therefore save more for old age. Moreover, the total return on their savings, and therefore their old-age income, is lower than for untested individuals, because they cannot participate in the insurance scheme. The story is different, however, when the frequency of testing during old age is at hand. In that case, for all survivors to the second period the uncertainty on their HIV status in the second period will be diminished. As a result, higher savings are now more 'efficient' in the sense that these higher savings can be allocated to the optimal mix of medical and regular consumption.

In conclusion, there is a striking analogy between the effects of HIV on savings and the welfare effects of testing for HIV. In both cases, the effects are negative during young age: HIV decreases savings and testing does not necessarily increase welfare, as tested individuals cannot share in the 'gift of the dying' through a longevity insurance scheme. If individuals perceive a higher probability of HIV contraction later in life, savings may increase and the savings will rise even more if the frequency of testing during old age increases. The higher savings then imply a welfare improvement.

Annex 5.1

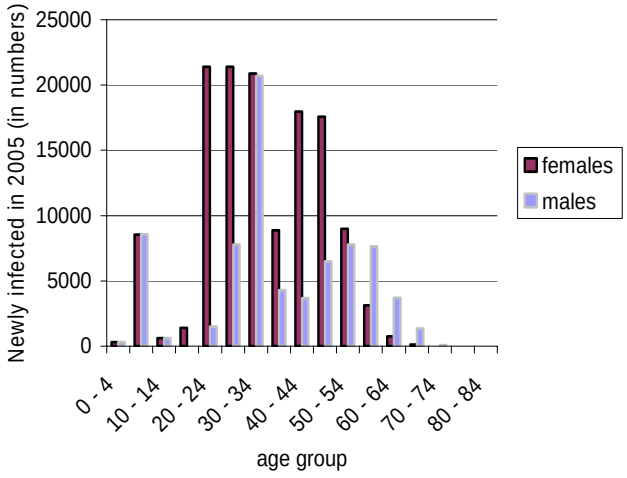
Table A5.1: Statistical model of the change in domestic saving rate.

	Period: 1990-1996 (Bonnel (2000))		Period: 1990-2004	
	Estimate	t-statistics	Estimate	t-statistics
Constant	0.46	0.1	-1.78	-0.26
Gross domestic savings (1990)	-0.28**	-2.8	-0.49*	-4.57
Secondary enrolment rate (1990)	-0.10**	-2.0	-0.02	-0.30
Growth rate of GDP per capita (1980-90)	86.60**	2.4	168.53***	3.43
Log of number of phones (1994)	2.49*	1.8	1.22	1.16
Log of HIV prevalence rate (1997)	-1.18	-1.5	0.56	0.59
Log of HIV prevalence rate squared	-0.61**	-2.6	0.19	0.43
Dummy variable for Southern Africa	10.20**	2.2	1.37	0.19

Dependent variable: Change in domestic savings rate

Annex 5.2

Figure A5.1: Estimated number of newly infected persons by gender in South Africa in 2005.



Source: Actuarial Society South Africa, 2007

Part III: Experimental Approach

Chapter 6

Perceived HIV-Contamination Risk, Risk Aversion and Time Preferences: A Laboratory Experiment in South Africa

6.1 Introduction

Part II of this thesis showed that both perceptions of HIV contamination risk and HIV status influence saving behavior. This poses the question what the characteristics are of individuals that are aware of the high HIV contraction risk. If these individual characteristics would mitigate saving behavior, this would limit the effect of the HIV anticipatory saving motive.

Risk and time preferences do not only play a central role in major economic decisions, like the amount of savings, but may also influence behavior that directly or indirectly affects the probability of getting ill at a later point in time. For example, the rapid spread of HIV in Southern Africa is often attributed to the fact that people in the region live a more day-to-day life compared to people in Europe of North America, which may be reflected by higher time preferences. High risk and time preferences make the long-term costs of risky sexual behavior relatively low compared to the short-term benefits of sexual pleasure (see Chapter 3, Section 3.4 for an analytical example). Moreover, people in developing countries face far more risks at relatively short time horizons, such as armed conflicts, natural disasters etc., in the event of which they will be confronted with large losses (De Weerdt & Dercon, 2006). Living in these

risky environments may induce people to be less precautious than people living in less risky environments.

Information on risk and time preferences is of obvious value for policy, theory and empirical analysis generally. Policy application includes cost-benefit analysis of government programs, which often require welfare calculations to be made over uncertain projects whose impacts are spread over time. Since the beginning of the epidemic, life expectancy has fallen dramatically in the countries hardest hit.[1] In South Africa, for example, life expectancy has fallen with almost 20 years in the past 20 years (U.S. Census Bureau, 2007). This significant change in mortality risk over this period may have affected individual risk attitudes and discount rates. These changes in risk and time preferences should be taken into account in welfare assessments of public policy reform.

This chapter estimates individual risk and time preferences in South Africa in order to test whether there are identifiable segments of the population, where individual risk and time preferences vary with the perceived risk of getting infected with HIV. It also analyzes whether sexual behavior is related to individual life expectancy and individual risk and time preferences. The analysis uses survey questions and experimental data collected among students in South Africa.[2] The experimental design closely follows Harrison et al. (2005a) to elicit both risk and time preferences from the same respondents. The experimental procedures build on the risk aversion experiments of Holt & Laury (2002) and the discount rate experiments of Coller & Williams (1999) and Harrison et al. (2002). Multiple price lists are used to measure individual risk attitudes and discount rates for a sample of 213 university students recruited at two South African universities. This information is related to survey questions about socio-demographic, financial and health characteristics.

A comparable study is Chesson et al. (2006) who associate individual discount rates with a range of sexual behaviors among a sample in the US. However, contrary to this study, they measure individual discount rates by offering subjects *hypothetical* rewards, instead of *real monetary* rewards. The subjects in this study, therefore, have a higher incentive to reveal their true preferences compared to subjects that are offered hypothetical rewards. Chesson et al. (2006) find that higher discount rates can be associated with risky sexual behavior. However,

[1] See Chapter 2 for more details.
[2] The appendix contains a detailed description of the study.

they do not find significant differences in discount rates for individuals infected with HSV-2[3] (a sexual transmittable disease).

This chapter finds that subjects who perceive to have a high HIV contamination risk as well as HIV positive subjects appear to be less risk-averse (even risk-seeking), compared to other subjects. As one would expect, subjects perceiving to be highly at risk display higher discount rates compared to all other distinguished groups. Surprisingly, however, subjects who are HIV positive appear to display significantly lower discount rates.

The next section describes the experimental design and Section 6.3 provides an overview of the experiments. Results from the experiments are discussed in Section 6.4 and conclusions are drawn in Section 6.5.

6.2 Valuation tasks

6.2.1 Risk aversion

This section employs a simple experimental measure for risk aversion called a multiple price list (MPL), which previously has been used by Holt & Laury (2002) and Harrison et al. (2005a). Each subject is presented with a choice between two lotteries, which are called A or B. Table 6.1 illustrates the basic payoff matrix presented to the subjects. The first row shows that lottery A offered a 10% chance of receiving 50 Rand and a 90% chance of receiving 40 Rand. The expected value of this lottery, EV^A, is shown in the fourth column as 41 Rand, although the EV columns were not presented to the subjects. For the exact table the reader is referred to Appendix D.1. Similarly, lottery B in the first row has chances of payoffs of 96.25 Rand and 2.50 Rand, for an expected value (EV^B) of 11.88 Rand. Thus the two lotteries have a relatively large difference in expected values, in this case 29.13 Rand. As one proceeds down the matrix, the expected value of both lotteries increases and the expected value of lottery B eventually exceeds the expected value of lottery A.

The subject chooses A or B in each row, and one row is later selected at random for payout for that subject. The logic behind this test for risk aversion is that only risk-loving subjects would take lottery B in the first row, and only risk-averse subjects would take lottery A in the second last row. Arguably, the last row is simply a test that the subject understood the

[3] Herpes Simplex Virus type 2.

instructions, and has no relevance for risk aversion at all. A risk-neutral subject should switch from choosing A to B when the EV of each lottery is about the same, so a risk-neutral subject would choose A for the first four rows and B thereafter.

Table 6.1: Payoff table for risk aversion task.

Decision	Option A	Option B	Expected payoff		Expected payoff	Open CRRA interval if subject switches to option B
			Option A	Option B	Difference	
1	R 50.00 if ball is 1-10 R 40.00 if ball is 11-100	R 96.25 if ball is 1-10 R 2.50 if ball is 11-100	R 41	R 11.88	29.13	-∞, -1.71
2	R 50.00 if ball is 1-20 R 40.00 if ball is 21-100	R 96.25 if ball is 1-20 R 2.50 if ball is 21-100	R 42	R 21.25	20.75	-1.71, -0.95
3	R 50.00 if ball is 1-30 R 40.00 if ball is 31-100	R 96.25 if ball is 1-30 R 2.50 if ball is 31-100	R 43	R 30..30	12.38	-0.95, -0.49
4	R 50.00 if ball is 1-40 R 40.00 if ball is 41-100	R 96.25 if ball is 1-40 R 2.50 if ball is 41-100	R 44	R 40.00	4.00	-0.49, -0.15
5	R 50.00 if ball is 1-50 R 40.00 if ball is 51-100	R 96.25 if ball is 1-50 R 2.50 if ball is 51-100	R 45	R 49.80	-4.38	-0.15, 0.14
6	R 50.00 if ball is 1-60 R 40.00 if ball is 61-100	R 96.25 if ball is 1-60 R 2.50 if ball is 61-100	R 46	R 58.75	-12.75	0.14, 0.41
7	R 50.00 if ball is 1-70 R 40.00 if ball is 71-100	R 96.25 if ball is 1-70 R 2.50 if ball is 71-100	R 47	R 68.13	-21.13	0.41, 0.68
8	R 50.00 if ball is 1-80 R 40.00 if ball is 81-100	R 96.25 if ball is 1-80 R 2.50 if ball is 81-100	R 48	R 77.50	-29.50	0.68, 0.97
9	R 50.00 if ball is 1-90 R 40.00 if ball is 91-100	R 96.25 if ball is 1-90 R 2.50 if ball is 91-100	R 49	R 86.88	-37.88	0.97, 1.37
10	R 50.00 if ball is 1-100	R 96.25 if ball is 1-100	R 50	R 96.25	-46.25	1.37, ∞

These data may be analyzed using a constant relative risk aversion (CRRA) characterization of utility, employing an interval regression model.[4] The CRRA utility of each lottery prize M is

[4] Holt & Laury (2002) use a two-parameter variant of the flexible Expo-Power (EP) utility function, originally developed by Saha (1993), which is more general than the CRRA characterization. The EP function nests CRRA and CARA. Holt & Laury (2002) estimate this function assuming that every subject has the same risk preference. They rely on a "noise parameter" to accommodate differences in risk choices across subjects, but they do not allow risk preferences to vary with socio-demographic characteristics as this in the later analysis of this chapter.

defined as $U(M) = \frac{M^{1-\gamma}}{1-\gamma}$ where γ is the CRRA coefficient.[5] The dependent variable in the interval regression model is the CRRA interval that subjects implicitly choose when they switch from lottery A to lottery B. For each row of Table 6.1 one can calculate the implied bounds on the CRRA coefficient, and these intervals are shown in the final column of this table. Thus, for example, a subject who made 5 safe choices and then switched to the risky alternatives would have revealed a CRRA interval between 0.14 and 0.41, a subject who made 7 safe choices would have revealed a CRRA interval between 0.68 and 0.97, and so on.[6]

The payoffs were in South African Rand (Rand) and the exchange rate was approximately 7.5 Rand for one Euro at the time of the experiment, so the prizes range from approximately 0.3 to 12.8 Euro.

6.2.2 Individual discount rates

The basic experimental design for eliciting individual discount rates (IDRs) was introduced in Coller & Williams (1999) and expanded in Harrison et al. (2002). Subjects in the experiments were given payoff tables such as the one illustrated in Table 6.2, with 20 symmetric intervals. In this example, Option A offered 172 Rand today and Option B paid 172 + X Rand in six months, where the amount X increased down the table reflecting annual effective rates of return ranging from 3% to 60% on the principal of 172 Rand. The payoff tables provided the annual effective interest rates for each payment option, and the experimental instructions defined these terms by way of example.[7] Subjects were asked to choose between Option A and B for each of the 20 payoff alternatives, and one decision row was selected at random to be paid out at the chosen date. If a risk-neutral subject prefers the

[5] With this parameterization, $\gamma = 0$ denotes risk-neutral behavior, $\gamma > 0$ denotes risk-aversion, and $\gamma < 0$ denotes risk-loving. When $\gamma = 1$, $U(M) = \ln(M)$.

[6] Following Rabin (2000), there are some specifications of the expected utility theory for which a finding of risk aversion at these levels of income is incoherent. This argument does not apply if expected utility is defined over income earned during the experiment, rather than over terminal lifetime wealth. Such specifications are standard in experimental economics, as well as in large areas of economic theory such as the analysis of auctions and contracts. Cox & Sadiraj (2006) and Harrison et al. (2007, Appendix) review these methodological issues in further detail.

[7] Coller & Williams (1999) and Harrison et al. (2002) provided annual and annual effective interest rates to help subjects compare lab and field investments opportunities. Subjects may make mistakes in converting dollar interest to an interest rate (or vice versa) for the purposes of comparison, and this treatment eliminates that type of error. The use of hypothetical or small payments is likely to exacerbate this problem because of the cognitive costs associated with the subject's arbitrage problem; at lower stakes subjects are likely to expend less cognitive effort on getting the comparison right.

172 Rand in one month then it can be inferred that his annual discount rate is higher than (x=100X/172)%; otherwise, it can be inferred that it is x% or less.[8] [9]

Table 6.2: Payoff table for discount rate task.

Decision	Option A To be paid today	Option B To be paid in 6 months	Annual Interest rate	Choice (Circle A or B)
1	R 172	R 174.59	3%	A B
2	R 172	R 177.20	6%	A B
3	R 172	R 179.83	9%	A B
4	R 172	R 182.47	12%	A B
5	R 172	R 185.14	15%	A B
6	R 172	R 187.83	18%	A B
7	R 172	R 190.53	21%	A B
8	R 172	R 193.26	24%	A B
9	R 172	R 196.00	27%	A B
10	R 172	R 198.77	30%	A B
11	R 172	R 201.55	33%	A B
12	R 172	R 204.35	36%	A B
13	R 172	R 207.18	39%	A B
14	R 172	R 210.02	42%	A B
15	R 172	R 212.88	45%	A B
16	R 172	R 215.76	48%	A B
17	R 172	R 218.66	51%	A B
18	R 172	R 221.57	54%	A B
19	R 172	R 224.51	57%	A B
20	R 172	R 227.47	60%	A B

The multiple-horizon treatment from Harrison et al. (2002) is used to analyze hyperbolic discounting. Subjects are presented with six discount rate tasks, corresponding to six different time horizons: 1 month, 4 months, 6 months, 12 months, 18 months, and 24 months.[10]

[8] It is assumed that the subject does not have access to perfect capital markets, as explained in Coller & Williams (1999, p.110) and Harrison et al. (2002, p.1607ff.). This assumption is plausible, but also subject to checks from responses to the financial questionnaire that each subject was asked to complete. For example, less than 10% of the subjects report to have a line of credit and among the subjects who report to have line of credit or a saving account, over 50% could not give an estimate of the interest rate they paid or received. Moreover, the standard deviations of the interest rates of those who could give an estimate are remarkably large. The effects of allowing for field borrowing and lending opportunities on the elicited discount rates for risk-neutral subjects are discussed by Coller & Williams (1999) and Harrison et al. (2004) discuss the general implications of allowing for extra-experimental trading opportunities on inferences from experimental responses.

[9] If subjects prefer the early payment for any interest rate, then the discount rate (in annual terms) of these subjects is assumed to be 63%.

[10] The design mimics the format used by Holt & Laury (2002) in their risk-aversion experiments: in that case the rows reflected different probabilities of each prize, and in this case the rows reflect different annual effective

Subjects were randomly allocated across two treatments that vary the delay to the early income option. In one set of tasks subjects are provided one "instant income" option and one future income option.[11] In another set of tasks subjects are provided two future income options. Following Harrison et al. (2002) a delay of one month is used for the early income option in all tasks. For example, subjects were offered 172 Rand in one month and 172 + X Rand in 6 months, so that the revealed discount rate is interpreted as applying to a time horizon of 5 months. This avoids the potential problem of the subject facing extra risk with the future income option, as compared to the "instant" income option. If the delayed option were to involve such additional risk, then the revealed discount rate would include a risk premium.

Each subject responded to all six discount rate tasks, and one task and one row were chosen at random to be played out. Future payments to subjects were guaranteed by Tilburg University and made by postdated checks that they could be cashed in at any Standard Bank branch in South Africa. Finally, each subject was given a 10% chance to receive actual payment. Thus, each subject faced a 10% chance of receiving payment in the risk preference task as well as a 10% chance in the time preference task.

6.3 The Experiments

A total of 213 students were recruited from Northwest University (NWU) and University of Pretoria (PU), conducted in two rounds, and spread across twelve sessions. Eleven sessions were conducted at Northwest University with eight sessions at Mafikeng campus and three sessions at Potchefstroom campus. One session was conducted at the University of Pretoria. To be able to have a substantial group of HIV positive students in the sample, the first round of experiments (in November 2005) was supplemented with two additional sessions conducted in HIV support group meetings (in October 2006). There were however no significant differences between Mafikeng HIV positive students from the HIV support session and those not from the HIV support group session for the main variables considered (see for more details Appendix A.1).

rates of return. This similarity of format was exploit in the use of trainers in the RA task as a generic substitute for trainers in DR rate task.

[11] The "instant income" option was paid out by a check and could be cashed in at any time after the experiment.

Table 6.3: Sessions and number of subjects.

	No. of Sessions		No. of nonwhite SA		No. of white SA		Total no. of subjects
Campus	**All**	**No-FED**	**All**	**No-FED**	**All**	**No-FED**	
Mafikeng	8	3	147	63	-	-	147
Potchefstroom	3	1	24	3	32	14	56
Pretoria	1	0	10	-	-	-	10
Total no. of subjects			181	66	32	14	213

Table 6.3 gives a summary of the sessions. Ages varied from 18 to 36 with an average of 22.6 years, and 54% were male. The sample consisted of 15% white and 85% nonwhite students at the two universities. Each subject was paid 30 Rand for participating in the experiment and they earned on average of 65 Rand in the valuation tasks.

The experiment was divided in five parts. Part I consisted of a questionnaire collecting subjects' socio-demographic characteristics. Part VI consisted of another questionnaire, which elicits information on the subject's financial market instruments, and probes the subject for information on their expectations about their future economic conditions and their own future financial position. The questionnaire in Part V asked questions on personal health including HIV status, sexual behavior and beliefs on HIV contamination risk exposure and personal life expectancy.[12] All questionnaires are reproduced in Appendix E. Since the survey contains highly sensitive questions, much effort was put in safeguarding the respondents anonymity. For example, questionnaires were collected by letting the subjects put their forms in a closed box. Appendix A.4 lists the measures taken.

Part II consisted of the risk aversion (RA) task, and Part III presented subjects with the six discount rate (DR) tasks. The RA task incorporates the incentive structure as described earlier. After subjects completed the task, several random outcomes were generated in order to determine subject payments. For all subjects, one of the decision rows in that task was chosen. To maintain anonymity the random draws were performed without announcing to

[12]Asking questions on individual sexual behavior and HIV status is of course sensitive and one might expect that individuals are not willing to answers such questions. The non-response was, however, very limited. It should be noted here that before the experiments were conducted, approval had to be obtained from the so-called ethical committee of NWU. The original set-up planned to offer the students a HIV test afterwards, but unfortunately, no approval was given for this. The results are therefore only based on perceived HIV contamination risk and self-reported HIV-status.

which subjects it would apply. Another random draw determined whether subjects were to receive the high payment or the low payment. Finally, each individual rolled a 10-sided die with numbers from 0 up to 9. Any subject who drew a roll of "0" received actual payment according to that final outcome. All payments were made at the end of the experiment.

A significant amount of time was spent training subjects on the task and the randomization procedures in Part II of the experiment. Subjects were given handouts containing examples of the MPL. The training exercise explained the logic of the MPL and a single trainer task was conducted in which payments were in the form of candies. Also in this training part, all random draws were generated and candies were given to each subject who received a roll of "0".

Finally, the six DR tasks, covering the six time horizons were conducted. Because these tasks also used the MPL format, with the same randomization procedures as the RA task, it was not necessary to repeat the training exercises. For a precise description of the experimental study, the interested reader is referred to Appendix A and C for the experimental script.

6.4 Results

This section describes differences in risk and time preferences in South Africa across different groups based on individual characteristics. In particular, it investigates whether HIV positive individuals and individuals who perceive themselves likely to get infected with HIV, have different risk attitudes and discount rates than other groups of the population. The section provides an overview of some of the preliminary results. All subjects made choices using the MPL instrument, with one RA task and six DR tasks creating a panel consisting of 7 observations per subject.

6.4.1 Risk aversion

The measurement of risk aversion in this chapter is situated in the context of a financial decision (i.e. choosing between lotteries). However, it has been noted in the literature that the willingness to take risks can vary from domain to domain (see Dohmen, et al. 2005). So, if individuals are willing to take a lot of risks in the financial domain, it does not imply that they will take the same amount of risk in the health domain. Strikingly, however, this section shows that in the risk-aversion experiments those individuals who perceive to

have a high-perceived risk of getting HIV contaminated are also willing to choose the risky lottery relatively often. This gives some confidence that the measure of risk is not too context specific to generate conclusions in the area of sexual behavior.

Table 6.4 provides the mean and standard deviation of the elicited CRRA coefficient, using the raw midpoint of the elicited interval. For this specification of CRRA, a value of 0 denotes risk-neutrality, negative values indicate risk-loving, and positive values indicate risk-aversion. Some subjects chose option B in the final row of the payoff table, which indicates that they did not understand the instructions, those 37 observations are therefore excluded from the risk attitude analysis. The sample based on 176 observations shows moderate risk aversion. The mean CRRA coefficient is 0.15 and the standard deviation is 0.63. This estimate is consistent with comparable estimates obtained in Colombia using college students and an MPL design, by Harrison et al. (2005c). However, the estimate is considerably lower than comparable estimates obtained in the US by Holt & Laury (2002) and Harrison et al. (2005d) and in Denmark by Harrison et al. (2005a).

Subjects may switch back and forth, as they move down the rows of the MPL. It is quite possible that this switching behavior is the result of the subject being indifferent between the options. The implication here is that, in the absence of an explicit indifference option, one could simply apply a "fatter" interval to represent the subject's risk preferences, defined by the first row that the subject switched at and the last row that at which the subject switched. A relatively high share of the subjects (60% of the 176 subjects) switched more than once as they moved down the rows of the MPL. The mean CRRA coefficient is 0.50 for the remaining 70 subjects that only switched once, and the standard deviation of the estimate is 0.81.[13] Appendix A.6 elaborates on this finding showing that multiple switching can be explained by indifferent behavior, although some part might also be explained by lack of skills. Offering an indifferent option would provide more insight in the switching behavior. Looking at individual characteristics, a mean CRRA coefficient of 0.56 among white students and 0.05 among nonwhite students is found, with a standard deviation of 0.68 and 0.59, respectively.

[13] A risk-aversion coefficient of 0.50 for these subjects is quite similar to the coefficients found by Holt & Laury (2002) (γ =0.66, US) and Harrison et al. (2005b) (γ =0.54, average CRRA elicited in Ethiopia, Uganda, and India). However, taking into account all subjects the average CRRA coefficient is much lower than these previous studies.

Table 6.4: Elicited CRRA values (midpoint of raw responses from MPL).

	Nonwhite		White		Single switch		All	
	N	γ (Std)	N	γ (Std)	N	γ (Std)	N	γ (Std)
Sexual debut								
No	12	0.24 (0.48)	19	0.64 (0.78)	24	0.63 (0.70)	31	0.48 (0.70)
Yes	132	0.04 (0.59)	13	0.44 (0.53)	46	0.42 (0.85)	145	0.07 (0.59)
p-value[14]		0.16		0.23		0.42		0.00
Use of condom (128 subjects report that they are sexually active)								
Regularly	106	0.02 (0.55)	6	0.51 (0.56)	30	0.36 (0.87)	112	0.04 (0.56)
Not regularly	14	0.14 (0.63)	2	0.83 (0.77)	5	1.11 (0.47)	16	0.23 (0.66)
p-value		0.90		0.51		0.04		0.53
HIV status								
HIV positive	20	-0.20 (0.63)	0	(-)	6	-0.48 (-)	20	-0.20 (0.63)
HIV negative	43	0.24 (0.66)	16	0.67 (0.81)	30	0.76 (0.73)	59	0.35 (0.71)
Never tested	74	0.04 (0.52)	16	0.44 (0.52)	34	0.43 (0.72)	90	0.11 (0.54)
P-value		0.26		0.15		0.00		0.02
Perceived HIV contamination risk (HIV positive subjects are not included)								
No risk at all	32	0.12 (0.54)	10	0.54 (0.45)	21	0.47 (0.60)	42	0.22 (0.54)
Small	55	0.17 (0.63)	20	0.49 (0.77)	35	0.63 (0.78)	75	0.25 (0.68)
Moderate	19	0.10 (0.60)	2	1.37 (0.00)	6	0.99 (0.84)	21	0.22 (0.69)
High	18	-0.17 (0.23)	0	(-)	2	-0.16 (0.22)	18	-0.17 (0.23)
Not high	106	0.14 (0.59)	32	0.56 (0.68)	62	0.61 (0.73)	138	0.24 (0.63)
p-value		0.02		(-)		-0.09		0.01
Personal life expectancy, expected age of death								
<55	26	-0.07 (0.49)	0	(-)	4	-0.02 (1.28)	26	-0.07 (0.49)
56-75	56	-0.05 (0.58)	20	0.62 (0.56)	32	0.41 (0.83)	76	0.13 (0.65)
>75	62	0.20 (0.59)	12	0.45 (0.87)	34	0.63 (0.71)	74	0.24 (0.64)
p-value		0.10		0.71		0.39		0.17
All	144	0.05 (0.59)	32	0.56 (0.68)	70	0.50 (0.81)	176	0.15 (0.63)

Although infection takes place through vertical transmission and through the health care system, most infections take place through risky sexual behavior. Therefore, one of the core questions of this chapter is whether there exists a relationship between sexual behavior and risk behavior. The elicited CRRA coefficients suggest that subjects who have not yet had their sexual debut are more risk-averse than subjects who already had experience with sexual intercourse. The mean CRRA coefficient is significantly different for these two groups and is 0.48 for subjects with no sexual experience and 0.07 for those with some experience (p-value=0.00). However, no significant relation for condom use was found. Most of the sexually active subjects use condoms regularly and they are on average less risk-averse than those subjects who do not use condoms on a regular basis. The mean CRRA coefficient is

[14] Two-sample Wilcoxon rank-sum (Mann-Whitney) test.

0.04 for those subjects who regularly use condoms and it is 0.23 for the other sexually active subjects, with a standard deviation of 0.56 and 0.66, respectively. It seems that being sexually active is more a token of risk-seeking behavior than using condoms or not. However, the dichotomous characteristics of the group that does not use condoms and are sexually active individuals might explain this finding: it consists of both persons being faithful to one partner and of persons having multiple. Unfortunately, the data does not allow to tests for possible differences in risk attitude between these two groups. Furthermore, the results are based on self-reported sexual behavior, such that socially accepted answers might be given with respect to condom use.

Ever having been pregnant, or ever having impregnated someone, is another indication of having had unprotected sex. These subjects might therefore be expected to be less risk-averse. On the other hand, children in developing countries are often seen as a type of income security, such that subjects that have ever been pregnant might display more risk-averse behavior as well. The first reasoning seems to apply only to male, but not to female subjects. Male subjects who have ever impregnated someone (n=13) have a risk-aversion coefficient of $\gamma = -0.07$, while males who have never made someone pregnant (n=82) have a significantly higher risk-aversion coefficient ($\gamma = 0.16$). For women, however, these figures are $\gamma = 0.19$ and $\gamma = 0.16$, respectively, which are not statistically significant different from each other. Female pregnancy thus seems to be less clearly related to risk behavior than male 'pregnancy'.

The next panel in the table shows the results for subjects grouped according to their self-reported HIV status. Among the RA sample twenty subjects[15] (11%) report to have been tested HIV positive[16], while 59 subjects (34%) state to have been tested HIV negative. More than half of all subjects report never to have undergone a HIV test. Notice that no white subject reports to have been tested HIV positive. The subjects seem to be largely aware of the HIV contraction risk. For instance, from the answers to the survey questions it appears that more than half of the subjects estimate the contraction risk of HIV to be high for *other*

[15] Although 23 subjects reported to be HIV positive, three of these were responding inconsistently on the risk-aversion tasks and are thus excluded from the analyses. These 3 subjects are however, included in the discount rate analysis in the next section.

[16] It might be mentioned that the found HIV prevalence rate of 11% is not too far from the rate found by others. For example, taking blood samples Pettifor et al. (2004) found a prevalence rate of 14% among the South African youth (20-24 years old).

students. Furthermore, 79% of the subjects ranked HIV/AIDS as number one cause of death in the North West Province.

Another key question is whether HIV status is related to risk behavior. Subjects who have tested positive for HIV appear to be risk-loving with a mean CRRA coefficient of −0.20 and a standard deviation of 0.63.[17] Subjects who prefer not to answer the question on HIV status, display similar risk-loving behavior (γ =–0.20). Subjects who have tested negative for HIV are risk-averse with a mean coefficient of 0.35 (standard deviation of 0.71), while those subjects who have never taken an HIV test have a mean CRRA coefficient of 0.11 with a standard deviation of 0.54. Comparing the CRRA of those who had ever got tested either positive or negative (0.21, N=79) and those who never got tested (0.11, N=90) shows that testing attracts a disproportionately large number of risk-averse HIV negative subjects.[18] None of the white students have reported a positive test result and they seem to be less likely to take a HIV test compared to nonwhite students. The white students in the sample perceive the HIV contamination risk as small compared to the nonwhite students, which may explain why white students are more reluctant to take a HIV test. Risk attitudes appear to be correlated with perceived high risk exposure: the mean CRRA coefficient is −0.17 for those subjects who perceive the contamination risk as high, whereas this coefficient is 0.24 for the other subjects. However, no substantial difference in risk aversion is found between those perceiving to have no, small or moderate HIV contamination risk.

Finally, the last panel in the Table 6.4 displays the relation between risk attitudes and personal life expectancy. Subjects with a relatively short expected lifetime are expected to be less risk-averse than subjects with a longer expected lifetime. Indeed, subjects who believe they will die before the age of 55 are risk-loving with a mean CRRA coefficient of −0.07 and a standard deviation of 0.49, while subjects who believe they will die after the age of 75 have a mean coefficient of 0.24 (standard deviation of 0.64). If risk preferences are associated with sexual behavior, these results would suggest that subjects are aware of the lifetime reducing consequences of their behavior.

[17] In the sample 23 subjects are tested HIV positive, which corresponds to a prevalence rate of 11%. Three of these subjects are excluded in Table 6.4 because they chose option A in the last row of the MPL for the RA task, but they are included in the analysis of time preferences. The health-related data is self-reported, but the HIV prevalence rate in the sample is similar to other studies based on blood samples (e.g. Pettifor et al. (2004)).

[18] Note that when considering only the first round of experiments, which consists of a random sample of tested and untested subjects, this difference is larger (CRRA tested=0.32) and significant at 10% level (p-value=0.06).

Overall, the raw midpoint estimates of the CRRA coefficient show a close association with being sexually active and the subjective perceived risk of getting or being HIV infected. Subjects who are sexually active, who perceive to have a high risk of HIV contamination and subjects who are HIV positive are on average significantly less risk-averse than other subjects. Moreover, subjects with these preferences seem to understand the lifetime reducing consequences of their associated behavior.

Table 6.5: Statistical model of risk-aversion responses.

Variable[19]	Estimate	Standard Error
Constant	0.15	0.68
Experimenter	0.28	0.22
Female	-0.08	0.16
Age	-0.04	0.02
White SA	0.76	0.24***
Urban	0.04	0.16
Smoke	-0.12	0.20
Lived in informal dwelling	-0.09	0.22
Prob. Of obtaining loan is small	0.07	0.16
Financially worse off than 2 years ago	0.09	0.18
Tested HIV positive	0.09	0.28
Tested HIV negative	0.31	0.17*
Prefer not to reveal status	-0.01	0.07
Perceives HIV risk as high	-0.54	0.24**
No sexual intercourse	0.01	0.23
No regular condom use	0.42	0.30
Life expectancy < 55 years	-0.01	0.24
Ranks HIV nr1	0.10	0.28
Ranks HIV nr2	-0.08	0.35

Interval regression, with the CRRA interval as the dependent variable, based on 176 observations.

Statistical model

Table 6.5 displays the interval regression model that explains the elicited CRRA values on several of the responses to the questionnaires. The statistical model supports the earlier finding on the raw data that subjects who have reported to be tested HIV negative are significantly more risk-averse compared to those subjects who have not been tested. The coefficient value is 0.31 with a p-value of 0.06. Subjects that perceive the risk of HIV contamination as high are less risk-averse, with a significant coefficient value of –0.54 (p-

[19] Appendix B.1 contains a description of the variables.

value=0.03). The significant effect of sexual experience on the risk-aversion coefficient disappears, however. Finally, white students appear to be significantly more risk-averse than nonwhite students. The coefficient value is 0.76 and the significance level is less than 0.01.[20]

6.4.2 Discount rate

Table 6.6 reports the elicited discount rates across the six time horizons, using the mid-point of the interval selected.[21] Again, in this task a remarkably large proportion of subjects (43%) switched more than once in the MPLs offered to the subjects, however this proportion is substantially less than in the RA tasks. The upper panel shows that the elicited mean individual discount rate (DR) is approximately constant across the six time horizons when the early reward is paid out immediately. The mean DR value is 46.23% for the 1-month horizon with a standard deviation of 22.72%, while the mean DR value is 46.61% for the 24-months horizon with a standard deviation of 22.01%. However, the discount rate falls over time when looking at the responses from the treatment where both rewards are delayed in time. The middle panel of the table shows that the elicited mean DR value falls from 39.81% for the 1-month horizon to a mean DR value of 34.05% for the 24-months horizon. Hence, the results suggest that individual discount rates are constant over time when the FED treatment is not applied, whereas it is falling over time when the FED treatment is applied. The data is pooled over the two treatments in the lower panel of the table, where a fall in the elicited discount rates can be observed as the time horizon increases.

These elicited values of the individual discount rates are higher than those reported in earlier studies using similar experimental designs. For example, Harrison et al. (2002) find that the estimated mean DR is 28.1% using a representative sample of the adult Danish population and six time horizons that vary between 1-month and 36-months. The estimates are also somewhat higher than the estimated rates found in Coller & Williams (1999), who report a median of 17.7% using a sample of college students at the University of South Carolina and a time horizon of 60 days.

[20] Tanner et al. (2005) find a similar result in their cross-cultural study, i.e. subjects from more collective culture groups and low-income locations display higher risk tolerance.

[21] The value of the discount rate is calculated by taking the midpoint of the interval in which the subject switches. If the subject switches more than once, then the coefficient is taken to be equal to the midpoint of the interval over which the subject is indifferent.

Table 6.6: Elicited discount rates and horizon (midpoint of raw responses from MPL).

	2 month	4 months	6 months	12 months	18 months	24 months
NFED						
N (valid)	79	78	80	78	79	79
Mean	46.23	47.61	46.83	46.01	47.02	46.61
Std	22.72	19.56	18.76	21.12	21.32	22.01
FED						
N (valid)	132	131	130	128	130	130
Mean	39.81	38.09	38.38	37.60	35.34	34.05
Std	21.27	19.45	20.00	20.11	20.43	19.89
Difference	6.42	9.52	8.45	8.41	11.68	12.56
p-value	0.07	0.00	0.04	0.01	0.00	0.00
All						
N (valid)	211	209	210	206	209	209
Missing	2	4	3	7	4	4
Mean	42.21	41.64	41.60	40.79	39.88	38.80
Std	22.00	19.99	19.92	20.87	21.46	21.55

The results show evidence for quasi-hyperbolic discounting for all six time horizons, i.e. subjects that completed the FED task have substantial lower discount rates than subjects that were assigned the nFED task. Note that this difference becomes larger when time horizons are lengthened, ranging from (6.4-12.6 percentage points). Harrison et al. (2005a) discuss that this result might be explained by transaction costs or distrust towards the experimenters. Because in both tasks students were paid by issuing a postdated check the results are not likely generated by a difference in transaction costs.

Table 6.7 provides the mean and standard deviation of the elicited discount rates across a few selected individual characteristics. The results in this table are based on the responses to the 24-months time horizon and show that white students in the sample on average have a higher discount rate than nonwhite students. The mean elicited DR is 42.5% for white students (with a standard deviation of 21.2%) and 38.1% for nonwhite students (with a standard deviation of 21.6%). The elicited discount rates also suggest that subjects who are sexually active are less patient in monetary matters than subjects who are not sexually active. The mean elicited DR is 35.4% for subjects with no sexual experience and 39.5% for those with some experience. Among the students with sexual experience the elicited DR is 37.6% for those subjects who regularly use condoms and 50.6% for those subjects who do not use condoms regularly. Hence, there appears to be a strong correlation between individual discount rates and the use

of contraceptives; subjects who regularly use condoms are considerably more patient than those subjects who do not seem to use contraceptives.

Table 6.7: Elicited discount rates (ρ) and personal characteristics (midpoint of raw responses MPL).

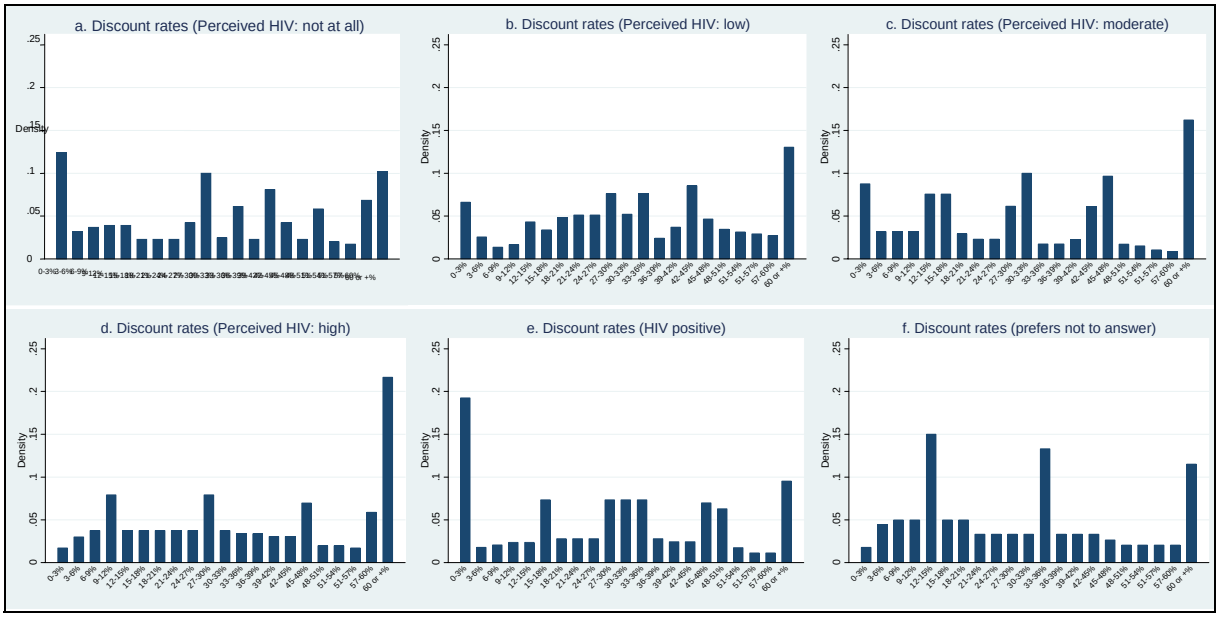
	Nonwhite		White		Single switch		All	
	N	ρ (std)	**N**	ρ (std)	**N**	ρ (std)	**N**	ρ (std)
Experience with sexual intercourse								
No	16	31.0 (14.8)	19	39.1 (22.2)	24	38.4 (21.2)	35	35.4 (19.3)
Yes	160	39.3 (22.4)	13	47.4 (19.3)	48	38.3 (25.4)	173	39.5 (22.0)
p-value		0.22		0.18		0.38		0.22
Condom use (only for those who reported to be sexually active)								
Regularly	130	36.6 (21.3)	11	49.8 (18.7)	43	37.1 (26.6)	136	37.6 (21.7)
Not regularly	15	52.8 (23.9)	2	34.4 (23.7)	5	45.9 (30.6)	17	50.6 (24.0)
p-value		0.04		0.24		0.00		0.07
HIV status								
HIV positive	23	25.7 (22.2)	0	(-)	6	43.9 (25.3)	23	25.7 (22.2)
HIV negative	52	40.5 (19.9)	16	45.2 (20.8)	30	42.1 (24.1)	68	41.6 (20.0)
Never tested	90	40.2 (22.2)	16	39.8 (21.9)	36	34.3 (23.7)	106	40.1 (22.1)
Not stated	10	36.2 (18.1)	0	(-)	0	(-)	10	36.2 (18.1)
p-value		0.03		0.56		0.06		0.02
Perception of HIV contamination risk								
No risk at all	42	36.5 (21.2)	10	46.0 (25.5)	24	32.0 (25.0)	52	38.4 (22.2)
Small	63	41.2 (20.2)	20	41.3 (19.3)	35	41.0 (22.4)	83	41.3 (19.9)
Moderate	24	38.2 (23.1)	2	36.4 (26.7)	5	37.2 (28.0)	26	38.1 (22.8)
High	24	44.6 (20.8)	0	(-)	2	54.5 (32.2)	24	44.6 (20.8)
Not high	129	39.2 (21.1)	32	42.4 (21.2)	64	37.3 (23.8)	161	39.8 (21.6)
P-value		0.45		(-)		0.03		0.26
Life expectancy: expected age of dying								
<55	28	36.3 (27.3)	0	(-)	3	29.5 (37.9)	28	36.3 (27.3)
56-75	72	38.7 (19.5)	20	45.1 (21.6)	34	41.1 (22.5)	92	40.1 (20.0)
>75	77	38.3 (21.5)	12	38.0 (20.6)	35	36.5 (24.6)	89	38.3 (21.3)
p-value		0.25		0.21		0.40		0.14
Total	177	38.13 (21.62)	32	42.5 (21.2)	120	40.51 (27.15)	209	38.80 (21.55)

The next panel of the table shows that subjects who have tested positive for HIV have substantially lower discount rates than subjects who have tested negative. The mean DR is 25.7% for subjects who have tested seropositive (with a standard deviation of 22.2%) and 41.6% for subjects who have tested negative (with a standard deviation of 20.0%). Considering the positive relation found between the discount rate and sexual behavior, this is a remarkable result. Although there does not appear to be a strong correlation between

discount rates and perceived HIV contamination risk, students that perceive to be highly at risk do display a higher discount rate.

Figure 6.1 shows the distribution of the revealed discount rates, disaggregated according to the subjects' own perceived HIV contamination risk. It appears that among the subjects who consider to have no HIV contamination risk at all, a relatively large percentage has the lowest discount rate, while, on the other hand, among subjects who perceive to have a high contamination risk a relatively large percentage has the highest discount rate. Panel d. and e., however, show a strikingly different pattern: while almost 25% of the subjects who perceive to be highly exposed to contracting HIV choose the early payment option, this was 13% for the HIV positive subjects whereas 35% choose to wait as long as possible. If the group that *perceives* to be highly exposed to contracting HIV would also *actually be* more at risk than the other groups, these results suggest that a positive diagnosis influences the individual discount rate. Finally, no linear relation is found between the DR and personal life expectancy.[24]

Figure 6.1 Discount rate and perceived HIV contamination risk.



[24] Note that this result may be driven by the large group of HIV positive subjects in the "low-life expectancy" group. Excluding these subjects from the analysis does show a negative relation of the discount rate over life expectancy.

Statistical model

Table 6.8 reports the results from a panel interval regression model, controlling for horizon and individual characteristics. These elicited rates are predictions for each individual from the estimated statistical model. This model uses panel data since each subject provided six interval responses, one for each horizon. The regression estimates show that all horizons have lower discount rates than the reference horizon, which is one month. The 24-months discount rate is approximately 4.9 percentage points lower than the 1-month discount rate, and the estimate has a p-value of 0.05. Also the FED treatment has a statistically significant effect on the elicited discount rate. The coefficient estimate is –7.24 with a p-value of less than 0.01, and this result confirms the observation from the raw data presented in Table 6.6.[25]

Looking at the impact of HIV status on the elicited individual discount rate, subjects who have tested positive on average appear to have a significant *lower* discount rate than those subjects who have never been tested. Having tested positive reduces the average discount rate by 14.34 percentage points (p-value less than 0.01), while having tested negative increases the average discount rate by 4.20 (p-value=0.02). These results are contrary to the *a priori* beliefs about the likely effects individual discount rates have on HIV infection and vice versa: High risk and time preferences make the long-term costs of risky sexual behavior relatively low compared to the short-term benefits of sexual pleasure and the reduced lifetime would lower the value individuals place on future benefits. The data, however, show that people who are infected with HIV have longer time horizons in financial matters than subjects who are not infected with the disease. There may be a sample selection issue, since all the subjects are university students. Hence, the subjects have already expressed interest in making a long-term investment in education and that may spill over to the estimated discount rates. Therefore, a different result may be found if similar experiments are conducted with subjects that are more representative of the adult population in South Africa. The "*HIV anticipatory savings motive*" introduced in the first part of this thesis may provide another explanation for the relatively low discount rates of HIV positive students: HIV positive subjects may anticipate the additional spending or drop in income they will likely face at the time they become AIDS-sick. In case they would not have enough resources to fully anticipate these expected illness costs, they may use the experiments as an opportunity to supplement their current savings and are therefore more willing to place a higher weight on the future benefits offered in the

[25] Coller & Williams (1999) also find a negative effect on the elicited individual discount rates from the FED treatment, but the estimated coefficient is not significant at conventional levels.

DR tasks. Chapter 7 will analyze the low DR of the HIV positive group in more detail. Finally, the statistical results show that sexually inexperienced subjects also are more patient in financial matters than subjects who already have had their sexual debut, which confirms the finding by Chesson et al. (2006).

Table 6.8. Statistical model of discount rate responses.

Discount rate	Coefficient	Standard Error
Constant	58.29	7.38
Horizon 4 months	-1.91	2.59
Horizon 6 months	-1.70	2.56
Horizon 12 months	-3.93	2.54
Horizon 18 months	-4.26	2.54*
Horizon 24 months	-4.93	2.52**
FED	-7.24	1.70***
Midpoint RA	-0.54	0.93
Experimenter	10.29	2.26***
Female	-4.92	1.67***
Age	-0.43	0.24*
White SA	5.66	2.50**
Urban	-0.08	1.67
Smoke	-2.12	1.99
Lived in informal dwelling	-2.50	2.32
Prob. of obtaining loan is small	4.54	1.58***
Financially worse off than 2 years ago	-2.38	1.80
Tested HIV positive	-14.34	2.77***
Tested HIV negative	4.20	1.74**
Prefer not to reveal status	0.61	0.69
Perceives HIV risk as high	1.03	2.51
No sexual intercourse	-5.09	2.47**
No regular condom use	12.00	2.75***
Life expectancy < 55 years	-3.44	2.31
Ranks HIV nr1	-9.09	2.86***
Ranks HIV nr2	-11.84	3.54***

Panel interval regression, with the discount rate interval as the dependent variable, based on 1176 observations.

Turning to the estimates of individual characteristics, women appear to be more patient than men. The estimated coefficient is –4.92 with a p-value of less than 0.01. This result is noteworthy since no previous study has reported a sex effect with respect to individual discount rates. Furthermore, relatively older students display lower discount rates than younger students. White students require a higher interest rate to invest in the lab instrument provided to them. This result contrast with Coller & Williams (1999) who find that nonwhite

students have nearly 21 percentage points higher discount rates than those revealed by whites.[26] Students are likely to be credit constrained and the results indicate that subjects with a small chance of obtaining a loan at the bank have higher individual discount rates. The coefficient estimate is 4.54 and has a p-value of less than 0.01.

6.4 Conclusion

This chapter elicited individual risk attitudes and discount rates from a convenient sample of students recruited at two universities in South Africa using monetary rewards. The elicited risk and time preferences differ across different groups based on perceived HIV contamination risk, HIV status, and sexual behavior.

Compared to previous studies using multiple price lists this study finds a remarkably large proportion of subjects that switch more than once in one of the tasks. Switching appeared more often in the risk aversion tasks than in the discount rate tasks. Computerized experiments forcing one switching-point would avoid the switching behavior, however, would not reveal subject's true preferences if no option is provided for being indifferent.

On average, the data show relatively large risk-tolerance and discount rates compared to those found by, e.g., Harrison et al. (2005a). Besides, this chapter finds evidence for hyperbolic discounting, i.e. the elicited discount rates were decreasing over longer time horizons, showing that time preferences appear not to be constant. Furthermore, removing the front-end delay makes the subjects less willing to accept delayed payment, which confirms quasi-hyperbolic discounting.

The subjects appear to be largely aware of the general HIV infection risk in South Africa. However only 13% considered *themselves* to be highly at risk and even 28% did not perceive to be exposed to HIV at all. Subjects who did consider to be highly prone to getting infected by HIV, are significantly less risk-averse, and tend to be less patient in the discount rate experiments. If these preferences carry over to their actual sexual behavior, as Chesson et al. (2006) and this study suggests, they complicate HIV prevention, since ignorance alone would not cause the further spread of HIV.

[26] One possible explanation for this result might be that as the payoffs used are, in real terms, much lower for whites than for nonwhites, the former group might find it less worthwhile to save on such low stakes.

HIV positive subjects appear to have significantly lower discount rates compared to subjects with negative test results. This finding is remarkable given the facts that most infections take place via unprotected sexual intercourse, and that high discount rates are associated with risky sexual behavior. However, all the subjects in the sample are university students. These students have already committed to making an investment in education, which suggests that the HIV infected subjects in the sample may have a relatively low discount rate. Another explanation could be found in the HIV anticipatory saving motive as described in the previous chapters. Being unable to anticipate the high future illness costs, subjects might have seen the experiments as an opportunity to supplement their savings.

Subjects that have been tested HIV-negative are significantly more risk-averse than subjects who have never been tested. HIV-testing seems thus to attract a disproportionately large number of risk-averse subjects. Although not significant at conventional levels, the results suggest that subjects that are sexually experienced are less risk-averse and display higher discount rates than subjects that do not have sexual experience. However, sexually active subjects who do not use condoms regularly did not display significantly different risk attitudes. They did display significantly higher discount rates than sexually active subjects who regularly do use condoms. Since unsafe sex appears to be partly an economic explicable choice related to individual risk and time preferences, HIV prevention focusing on providing information alone is not sufficient in preventing the disease from spreading further.

Chapter 7

HIV/AIDS, Risk Aversion and Intertemporal Choice

7.1 Introduction

This chapter analyses the relation between perceived health status and intertemporal choice. Data is used from experiments with real monetary rewards conducted among students in South Africa to estimate risk and time preferences. These experiments are based on multiple price lists developed by Coller & Williams (1999), Holt & Laury (2002), and Harrison et al. (2002, 2005a). Using the same experimental data, Chapter 6 showed that both HIV positive agents and participants engaging in risky behavior are less risk-averse. However, although the latter group display higher discount rates, HIV positive agents seem to have substantially lower discount rates compared to the other students in the sample, indicating longer time horizons in spite of their lowered life expectancy. This chapter in particular studies this paradoxical finding. In doing so, some of the initial findings of the previous chapter will be revisited, such that this chapter can be read independently from Chapter 6.

HIV/AIDS is the leading cause of death among young adults in Africa. Much of the international effort to help has focused on improving access to ARV treatment. Even in relatively developed South Africa, only 21% of those in need of ARV treatment have access to it (WHO, 2006); for the largest part of Africa access to treatment is even more restricted.

But with 3 million people getting infected by HIV each year in Sub-Saharan Africa alone (WHO, 2006), prevention too has to play a crucial role if the disease is ever to be brought under control. Risky sexual behavior (promiscuity, unprotected sex, etc.) significantly increases the probability of infection. Therefore, knowledge of why people engage in such practices in spite of the potentially very serious consequences they may lead to, is crucial for the design of effective prevention programs. If it is ignorance, education should be the main focus of such programs. But if people persevere with unsafe sex simply because they are less risk-averse or value the future less than those that do not, education may well be insufficient.

Risk aversion and time preference are likely to have an impact: unsafe sex increases the risk of getting infected, so the more risk-averse one is, the more one should be willing to take precautions to reduce infection risks. Equally, unsafe sex trades off current benefits (presumably) against future costs; thus the more the future is discounted, the less the weight one attaches to avoiding those costs. (Chapter 3, Section 3.4 provides an analytical example.) If those engaging in risky sexual behavior tend to be less risk-averse or discount the future more heavily, education on the possibly disastrous consequences of unsafe sex may not be enough and other methods need to be developed to get people to refrain from risky sexual behavior.

There is extensive literature linking HIV infection to socio-demographic characteristics. For example, Pettifor et al. (2004) and Harris & Van Aardt (2007) find that HIV infection is higher among young single, tertiary educated, and low socio-economic class persons. Literature that associates sexual behavior with quantified risk and time preferences scarcely exists. Using hypothetical questions and survey data in the US, Chesson et al. (2006) show that time preferences are significantly associated with a range of sexual behaviors and experiences, like ever having sex, having sex before the age 16 years, and past or current pregnancies. However, they do not find significant differences in discount rates for individuals infected with HSV-2[1] (a sexual transmittable disease). Moreover, the use of hypothetical questions has become controversial as a way to elicit preference parameters, supported by, for example, Holt & Laury (2002) who find significantly different answers between hypothetical and real experiments with high pay-offs.

[1] Herpes simplex virus type 2.

Therefore, in this study data is used generated from trials using actual monetary rewards, conducted among students in South Africa, to investigate the relation between risky sexual behavior and risk and time preferences. In these trials, students were asked to make a series of choices between alternatives with different risk characteristics and timing of (real monetary) rewards. They were also asked to provide extensive information about their health status, economic circumstances, and sexual behavior.

Both HIV positive students and students, who perceive to be highly at risk of contracting the virus, appear to be less risk-averse. However, as also showed in Chapter 6, with respect to the raw estimates of time preferences a paradoxical result emerges: Although there is evidence of a positive correlation between risky sexual behavior and discount rates, people who are actually HIV infected seem to have much lower discount rates than those who are not. More thorough analysis shows that this result is due to the implicit assumption made by most researchers in this field, that only the pure rate of time preference features in the pricing of future benefits. This chapter shows that once other factors than just the pure rate of time preference are incorporated in the pricing of future benefits, this seeming anomaly disappears and the results do conform to prior expectations. Differential expectations about mortality rates, risk attitude, and future disposable income levels turn out to be major explanatory factors of differences in valuing future events and explain most of the puzzling results on rates of time preference earlier research have obtained.

Similarly, this chapter also shows that conclusions on hyperbolic discounting become biased when failing to incorporate the other factors mentioned in the analysis of intertemporal choice. On uncorrected data, the hypothesis of hyperbolic discounting is accepted, but once differential expectations on mortality rates, risk preferences and future levels of disposable income are incorporated, the hypothesis is rejected.

The chapter is organized as follows. The next section provides the theoretical framework for eliciting risk and time preferences. Section 7.3 presents the experimental method and the results assuming that only the pure rate of time preference influences the pricing of future benefits, which leads to the seeming paradox on HIV status and discount rates. Section 7.4 introduces mortality, risk attitude and differential expectations about future consumption levels into the analysis and tests for hyperbolic discounting. Section 7.5 concludes.

7.2 Eliciting risk and time preferences: a standard approach

Assume that expected utility theory (EUT) holds for choices over risky alternatives and that subjects have a constant relative risk aversion (CRRA) utility function defined over the prizes they make choices over:

$$U(M_t) = \frac{M_t^{1-\gamma}}{1-\gamma} \tag{7.1}$$

where $U(M_t)$ is the utility of monetary outcome M_t at time t and where γ is the CRRA coefficient. For $\gamma = 1$, this function is defined as $U(M_t) = \ln(M_t)$, for $\gamma = 0$, the agent is risk-neutral, for $\gamma > 0$ the agent is risk-averse, and for $\gamma < 0$ the agent is risk-seeking. Furthermore, assume that discounting is exponential. Consider two certain monetary outcomes (M) at time t and at time $t+k$. An agent is indifferent between these two outcomes if the following equation holds:

$$\begin{aligned} &U(M_t) = D(k)U(M_{t+k}) \\ &\text{where} \quad D(k) = \frac{1}{(1+\rho)^k} \end{aligned} \tag{7.2}$$

$U(M_t)$ is again the utility of monetary outcome M_t at time t as specified in Equation (7.1). k is the horizon for late delivery of monetary outcome M_{t+k}. $D(k)$ is the discount function, which can be interpreted as the relative weight an agent attaches to utility of M_{t+k} at time $t+k$ compared to utility of M_t at time t, and ρ the pure rate of time preference.[2] If agents are risk-neutral (i.e. $\gamma = 0$), Equation (7.2) can be written as follows:

$$M_t = \frac{1}{(1+\rho)^k} M_{t+k} \tag{7.3}$$

If agents value two monetary outcomes M_t and M_{t+k} equally, the implicit value of ρ can be derived for which Equation (7.3) indeed holds as equality. In line with earlier literature (Harrison et al. (2002) and Coller & Williams (1999)) and has been done in Chapter 6, also

[2] The pure rate of time preference measures the preference for immediate utility over delayed utility.

this chapter initially simplifies the procedure by assuming risk neutrality to derive the implicit value of ρ, but relaxes this assumption later on.

7.3 Experimental data

For the analysis, data is used from experiments conducted among students of the North West University and the University of Pretoria in South Africa. The experimental procedures are documented in detail in Appendix A and build on the risk aversion (RA) tasks of Holt & Laury (2002) and on the discount rate (DR) tasks of Coller & Williams (1999), and closely follow the experimental procedures of a Danish field experiment by Harrison et al. (2002, 2005a).

Stimuli

In short, each student was asked to complete one RA task and six DR tasks (see Appendix D for the specific tasks). Each task involved a series of binary choices, in the RA task 10 and in the DR tasks 20 per task. In the RA task, subjects were asked to choose between two risky lotteries, where the probability of winning the higher price increased along the table. The point at which subjects switch from the less risky to the more risky option was used to deduce the subject's risk preference parameter. In the six DR tasks, subjects were asked to choose between two certain outcomes: a present and a future payment. The various DR tasks differed in the timing of the future payment: the delay increased from 1 to 3, 5, 11, 17, and finally 23 months. If not specified differently, this chapter studies the elicited discount rates from the longest time horizon, i.e. the DR task in which the delayed payment option was 23 months. Also in the DR tasks, the point at which the subject switches puts a bound on his discount rate. For each individual, the unconditional discount rate is estimated by taking the average discount rate when a subject switches from choosing the current to the future payment option. If subjects switch more than once between the two options, the discount rate is assumed to be equal to the midpoint of the interval over which the subject is indifferent.

Treatments

Because there is empirical evidence that agents are more impatient about immediate delays than they are about future delays of the same length (Coller & Williams, 1999), the timing of the present option was varied between treatments. 38% of the subjects was asked to choose between receiving an amount today or in the future (called no Front-End-Delay (nFED)). The other subjects were asked to choose between *two* future options (called Front-End-Delay

(FED): the first payment option was 1 month, and the other, 2, 4, 6, 12, 18 and 24 months, such that the length between the treatments remained the same in both sets of experiments. This allows us to test for (quasi)-Hyperbolic-Discounting.

Motivating participants

Real incentives were used to motivate participants. In addition to the fixed participation fee of 30 Rand (1 Rand equals about 0.14 USD in the year of the experiments), all subjects had a 10% chance of being selected for actual payment according to the choice they made in each of the two tasks. On average participants could earn 65 Rand in the valuation of the task. This performance-based, random lottery real incentive system is nowadays used by most researchers as incentive structure for individual choice experiments (Holt & Laury, 2002).[3] Subjects selected for additional payment in the DR task, received a postdated check issued by Tilburg University, which could be cashed at any Standard Bank in South Africa any time after the specified date.

Questionnaires/sample characteristics

Subjects were asked to fill out three different questionnaires: a socio-demographic, a financial and a health questionnaire.[4] Among other health related issues, subjects were asked to report on their HIV status, and on how they perceive their chances of getting HIV infected during their lifetime. In the latter, they were asked to choose between: no risk at all (1), small (2), moderate (3), and high (4). This chapter analyzes differences in risk and time preferences among 5 groups: the first four are based on the subject's self-reported perceived HIV contamination risk, group 5 consists of subjects who have actually contracted HIV.

Participants

The total sample includes 213 subjects, 53.5% males, and 46.5% females. 85.0% of the respondents are nonwhite and 15.0% are white South African students. The age-range among white participants is smaller compared to nonwhite participants, ranging between 19-24 and 18-36 respectively, with a mean age of 21.1 years for white participants and 22.9 years for nonwhite participants. The overall reported HIV prevalence rate among the sample is 9.8%[5].

[3] The main advantage of this system is that it avoids income effects such as Thaler & Johnson's (1990) house money effect. It has been shown empirically that players do not interpret choice tasks rewarded with the random lottery incentive system as one grand overall lottery (Cubitt et al. 1998, Starmer & Sugden 1991).
[4] See Appendix E.
[5] Note that in the first round of experiments alone, this percentage would be 3.0%.

Another 4.7% of the subjects indicated to prefer not to report their HIV status or to answer the question about whether or not they had ever been tested for the virus. This prevalence rate is comparable with the average prevalence rate (9.9%) among the youth in the North West province (Pettifor et al., 2004), but the observed prevalence rate is high considering their finding that among the youth that are HIV positive only 10% is also aware of their status. The reported perceived contamination risk varied among the sample. For instance, 10.4% of the respondents perceived their HIV contamination risk as high, and 23.3% indicated that they would face no risk at all to contract the virus. The largest proportion (44.8%) answered to have a small and 11.6% reported to have a moderate risk of contracting HIV during their lifetime.[6]

Sample selection criteria

From the 213 subjects, 1 subject did not reveal his perception of HIV contamination risk, 4 subjects did not completely fill out the DR task, 14 subjects did not reveal their expected age of death, and 36 participants did not answer consistently[7] in the RA task. Removing these subjects from the sample leaves 163 subjects for the analysis.[8] The discount rates elicited from the 163 subjects considered, do not significantly differ from those elicited from the subjects removed from the sample (p-value[9]=0.68).[10]

Results I: attitude towards risk

Using the switching-point in the RA tasks to elicit the risk-aversion parameter, a CRRA coefficient (γ) of 0.16 is found, which is rather low compared to the student population of the subjects in Holt & Laury (2002) (γ=0.66, USA), or Harrison et al. (2005b) (γ=0.54[11]). However, Tanner et al. (2005) found even on average lower values in their cross-cultural study for Niger (ranging between –0.15 and 0.14). It is intriguing that studies estimating risk preferences from asset prices using CAPM find much higher values than are obtained in all these experimental studies, this study included (see for example Cochrane (2001)).

[6] Appendix A.5 contains detailed information on the characteristics of the participants.
[7] With "not consistently" is meant that subjects choose the small prize when both options were sure (i.e. option A in decision row 10, in Table D1 of Appendix D).
[8] Note that the sample used in this chapter is smaller than the sample used in the previous chapter. The reason for this is that the analyses in this chapter make use of the self-reported expected lifetime which was not available for all subjects.
[9] Based on Mann-Whitney test.
[10] For more details on the sample selection, see Appendix A.6.
[11] γ=0.54 is the average risk aversion coefficient elicited in Ethiopia, Uganda, and India.

Table 7.1 shows that the CRRA coefficient is statistically different for the five groups based on HIV status and perceived HIV contamination risk (p-value=0.02). The results also suggest a negative relation between perceived HIV contraction risk and risk aversion. A simple regression gives a slope coefficient of –0.13 with p-value 0.03. In fact for the two highest groups, γ is actually negative on average, indicating risk-loving or a convex utility function.

Table 7.1: CRRA coefficients (γ).

Perceived HIV contraction risk	N	γ	Std. Dev.
Group 1: no risk at all	38	0.24	0.56
Group 2: small	73	0.26	0.68
Group 3: moderate	19	0.18	0.67
Group 4: high	17	-0.17	0.24
Group 5: HIV+	16	-0.20	0.70
All	163	0.16	0.64

Results II: rate of time preference

The mean (annualized) discount rate implied by subjects' choices for the longest time horizon is 39.23%, although there is substantial variation around the mean (see Table 7.2). This section interprets this value as an estimate of the pure rate of time preference. This estimate is much higher than, for example, real market borrowing rates in South Africa, which were around 2.3%[12] at the time when the experiment was conducted.

Table 7.2: Discount rate, ρ (in %).[13]

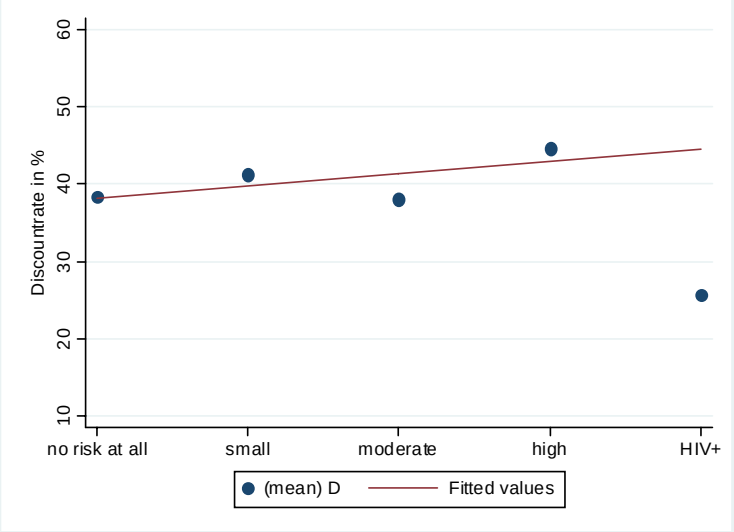
Perceived HIV contraction risk	N	ρ	Std. Dev.
Group 1: no risk at all	38	40.73	22.39
Group 2: small	73	41.37	20.20
Group 3: moderate	19	39.96	22.80
Group 4: high	17	44.29	20.69
Group 5: HIV+	16	19.63	21.81
All	163	39.23	21.98

[12] Based on inflation and prime rates 2005, source: EcoWin.

[13] These estimates differ slightly from Chapter 6, because 163 instead of 176 subjects are used due to the additional sample selection criteria that are required for the analyses in this chapter.

Analyzing the results for different groups separately produces a surprising result. Although Table 7.1 showed a clear negative relation between risk aversion and the risk grouping of contracting HIV, the relation found between discount rate and the risk group of those who actually contracted HIV does not seem to conform with expectations at all (see Table 7.2). Thus, experimental data seems to reject that seropositive agents have higher discount rates. In fact, the opposite relation holds: HIV positive agents have significantly lower discount rates (Δ=–21.73, p-value=0.0006, where Δ equals the difference between HIV positive agents and all other agents). Table 7.2 and Figure 7.1, however, do show an admittedly weak positive link between risk exposure and discount rates among the groups that have not yet actually contracted the virus: discount rates of agents that *perceive* to be highly at risk of getting infected *are* higher than those of agents that perceive not to be highly at risk. Drawing a regression line through the data points of the first four groups only, weakly confirms the expected positive relation between the rate of time preference and perceived HIV contraction risk. A regression yields a slope coefficient of +0.93, but with a high p-value (0.37). Including the fifth data point of HIV positive subjects leads to a distinct negative slope although also not significantly (–3.93, p-value=0.26).[14] The discount rate of this group seems to be an outlier in the expected positive relation between discount rate and perceived contamination risk.

Figure 7.1: Rate of time preference.[15]



We are thus left with a puzzle: The relation between coefficients of risk aversion and risk exposure do conform to the expectations, but the results on the rate of time preference do

[14] Removing however any other of the 4 data points leads to a distinct negative slope.
[15] Regression line through the first four data points, i.e. excluding the HIV+ group.

not. While there seems to be a weak positive link between increasing risk exposure and discount rates, including HIV positive agents reverses that link. HIV positive subjects actually show significantly lower discount rates. This is remarkable because considering sexual behavior, the results in the data point in a different direction. For instance, sexually active agents display higher discount rates (ρ (sex)=40.07 (n=133) vs. ρ (no sex)=35.47 (n=30), p-value=0.15), be it that the difference is not statistically significant.[16] Furthermore, agents that are sexually active and do not take preventive measures, i.e. who reported to not regularly use condoms, have a significantly higher discount rate (ρ (no condom)=51.71 (n=14) vs. ρ (condom)=38.07 (n=106), p-value=0.06[17]). Since these behavioral variables are positively correlated with the risk of contracting HIV, why do we not find this relation for HIV positive agents in the data?

7.4 Explaining the paradox

The results on discount rates and risk classes obtained so far seem paradoxical. However, the assumption that the pure rate of time preference is the only factor entering the pricing of future benefits is extremely limiting and very likely biases the results. This section first considers differential mortality risk as an additional factor entering the relevant discount rate and then various ways of incorporating anticipated changes in marginal utility of consumption over time. The results will change significantly once these additional factors are taken into account.

7.4.1 Correcting for mortality risk

An individual cannot derive utility from consumption in a certain period unless he has survived the preceding periods. Therefore, uncertainty of survival leads households to discount the future more heavily (Yaari, 1965). HIV obviously decreases actual life expectancy of HIV positive agents. Especially in developing countries where the availability of medicines is insufficient, being HIV infected means premature death.[18] Variation in mortality risk may

[16] Excluding the HIV+ group the difference is statistically significant ρ (sex)=42.87 (n=117) vs. ρ (no sex)=35.47 (n=30), p-value=0.04.

[17] Excluding the HIV+ group this difference is not significant: ρ (no condom)=51.71 (n=14) vs. ρ (condom)=41.20 (n=91), p-value=0.15. However, Chapter 6 shows using a panel interval regression that after correcting for individual characteristics, both sexually active and sexually active no-condom users have significantly higher discount rates (see Table 6.8)

[18] In South Africa 21% of people with advanced HIV infection receives antiretroviral therapy (WHO, World Health Statistics 2006). Median time from seroconversion (clinical latency) to AIDS in east Africa is estimated to be 9.4 years. The median survival time after the progression to AIDS is 9.2 months (Morgan et al., 2002).

therefore explain differences in the implied individual discount rate among different risk groups.

Suppose agents have an annual survival probability p. Then the probability of surviving k periods ahead equals $S_{t+k} = p^{k-t}$. Equation (7.4) then shows the mortality risk inclusive discount rate (ρ^{mc}) an agent will use in period t to price her well-being in period $t+k$, where ρ equals the pure rate of time preference, conditioned on staying alive.

$$\left(\frac{1}{1+\rho^{mc}}\right)^{k} = \frac{S_{t+k}}{(1+\rho)^{k}} \tag{7.4}$$

Substituting the survival function in (7.4) and solving for the pure rate of time preference, gives:

$$\rho = (1+\rho^{mc})\,p - 1 \tag{7.5}$$

For the specific sample of people considered p is unknown, but the health questionnaire did include the question "*how long do you expect to live?*" from which the expected time until death was elicited. Under the simplifying assumption of a constant annual survival probability, there is a simple relation between survival probability p and the expected time until death, $E(T_D)$, so that p can be calculated (see Annex 7.1):

$$p = \frac{E\,(T_D) - 1}{E\,(T_D)} \tag{7.6}$$

Since p is increasing in $E(T_D)$, the unconditional discount rate, presented in Table 7.2, is biased upwards if interpreted as an estimate of the pure rate of time preference, as was done in Section 7.3. Not correcting for mortality risk will therefore create a bias in the results when comparing groups with different perceptions of HIV contamination risk, since they are likely to have different expected survival times.

Table 7.3 shows that the expected time until death indeed varies across the five groups and is decreasing in perceived risk exposure (corr=– 0.32 , p-value=0.0000). Average expected time

until death at the time of the experiment is 49.12. The difference is highly significant across the five groups based on the Kruskal-Wallis test (p-value=0.0001). HIV positive subjects estimate the time until death on average 30.31 years from now, which is substantially lower (by 22.19 years) than the expected lifetime of the group who thinks to have no risk at all to contract the virus during their lifetime. This shows awareness of the lifetime reducing consequences of HIV infection.

Table 7.3: Expected time until death, $E_0(T_D)$.

Perceived HIV contraction risk	N	$E_0(T_D)$	Std. Dev.	α
Group 1: no risk at all	38	52.50	18.47	0
Group 2: small	73	52.29	16.08	0.01
Group 3: moderate	19	48.58	18.57	0.18
Group 4: high	17	46.24	15.88	0.28
Group 5: HIV+	16	30.31	11.60	1
All	163	49.12	17.65	0.15

Assuming that group 1 has no risk of contracting the virus, indicated by α_1=0, and considering the fact that group 5 is infected with probability α_5=1, the expected lifetime of the other 3 groups can be expressed by Equation (7.7) and the corresponding infection probabilities, α_i, of these groups can be elicited. Both the infection probability of the moderate group (α_3=0.18) and the weighted average ($\bar{\alpha}$=0.15) are close to the adult prevalence rate of South Africa, which was 18.8% (UNAIDS, 2006) at the time the experiments were conducted.

$$E_0(T_D)_{Gi} = (1-\alpha_i)E_0(T_D)_{G1} + \alpha_i E_0(T_D)_{G5} \tag{7.7}$$

However, although the subjects seem to consider HIV infection risk in their expectations of lifetime, it appears that for 3 out of the 5 groups subjects not having medical insurance on average estimated their lifetime higher than those with medical insurance. Apparently, these groups do underestimate the consequences of infection on expected lifetime without appropriate treatment.

Based on the individual expected remaining lifetime the survival probability p is calculated and the correction for mortality is applied in estimating time preferences using Equation (7.5). Table 7.4 shows that correcting for mortality decreases the estimate of the rate of time preference on average by 1.15 percentage points. The correction differs across the five groups; even though p is the lowest for the HIV positive group, the correction for this group is the lowest due to their relatively low "raw" discount rate. Correcting for mortality, however, reduces the discrepancy between the estimated discount rate of those subjects that perceive to be highly at risk and seropositive subjects (0.28 percentage points). In countries with large differences in mortality risk, as in high HIV prevalence countries like South Africa where 18.8% of the adult population is infected (UNAIDS, 2006), not correcting for mortality in eliciting individual discount rates thus biases estimates for time preferences and distort the comparison between groups in society based on them. On the horizons considered, however, the corrections are not large compared to the underlying estimates and the counterintuitive result for HIV positive agents is still there.

Table 7.4: Rate of time preference before (ρ^{uc}) and after (ρ) correction discount rates for differential mortality rates.

Perceived HIV contraction risk	N	Mean	Std. Dev.
Group 1: no risk at all			
ρ^{uc}	38	40.73	22.39
ρ	38	39.17	22.34
$\rho^{uc} - \rho$		1.56	
Group 2: small			
ρ^{uc}	73	41.37	20.20
ρ	73	40.36	19.83
$\rho^{uc} - \rho$		1.01	
Group 3: moderate			
ρ^{uc}	19	39.96	22.80
ρ	19	38.95	22.14
$\rho^{uc} - \rho$		1.01	

Perceived HIV contraction risk	N	Mean	Std. Dev.
Group 4: high			
ρ^{uc}	17	44.29	20.69
ρ	17	43.09	20.07
$\rho^{uc} - \rho$		1.19	
Group 5: HIV+			
ρ^{uc}	16	19.63	21.81
ρ	16	18.72	20.63
$\rho^{uc} - \rho$		0.91	
All			
ρ^{uc}	163	39.23	21.98
ρ	163	38.08	21.56
$\rho^{uc} - \rho$		1.15	

7.4.2 Relaxing the assumption of risk neutrality

Table 7.1, including estimates for risk preferences, may point part of the way to a solution to the puzzle: so far the calculation of the rate of time preference assumed risk neutrality, but this table shows that risk tolerance differs across groups and is significantly higher among high-risk groups. Besides, Andersen et al. (2005) show that joint elicitation of the CCRA coefficient and discount rate, substantially lower discount rates compared to eliciting the two separately. Under the expected utility framework used here, the same parameter measuring risk aversion also measures (the inverse of) the intertemporal substitution elasticity. Assuming risk neutrality (linear utility), therefore, could have biased the elicited discount rate for these agents and the differences between the five risk exposure classes.

Combining Equations (7.2) and (7.4) leads to the following estimate for the rate of time preference corrected for mortality and curvature (see Annex 7.2 for the derivation):

$$\rho = \left[\frac{S_{t+k}}{S_t} \left(\frac{M_{t+k}}{M_t} \right)^{1-\gamma} \right]^{1/k} - 1 \qquad (7.8)$$

Assuming that the intertemporal substitution parameter (inverse of the intertemporal rate of substitution) is equal to the risk parameter obtained from the static risk experiment[19], ρ can be calculated. Note however that, while $\gamma < 0$ is possible in the context of risk, $\gamma < 0$ is not an admissible value in the context of intertemporal choice. For one thing, it would imply that the first order conditions determining intertemporal choice correspond to a welfare minimum instead of a welfare maximum. Therefore, this part of the analysis is restricted to individuals with $\gamma > 0$, which means removing 73 risk-seeking subjects from the sample. The discount rate for the group with $\gamma < 0$ is not significantly different from the value obtained for the group with $\gamma \geq 0$ (p-value =0.18), whether the correction for mortality risk is applied or not.

Table 7.5: Discount rates corrected for mortality only (ρ^M) and for mortality and risk attitude (ρ). Sample with $\gamma \geq 0$.

Perceived HIV contraction risk	N	Mean	Std. Dev.
Group 1: no risk at all			
γ	23	0.58	0.43
ρ^M	23	37.15	24.13
ρ	23	19.36	17.31
$\rho^M - \rho$		17.79	
Group 2: Small			
γ	46	0.64	0.50
ρ^M	46	42.49	20.71
ρ	46	21.76	22.04
$\rho^M - \rho$		20.73	
Group 3: Moderate			
γ	8	0.79	0.59
ρ^M	8	49.15	27.12
ρ	8	24.64	29.87
$\rho^M - \rho$		24.50	

[19] As is always the case within the expected utility framework.

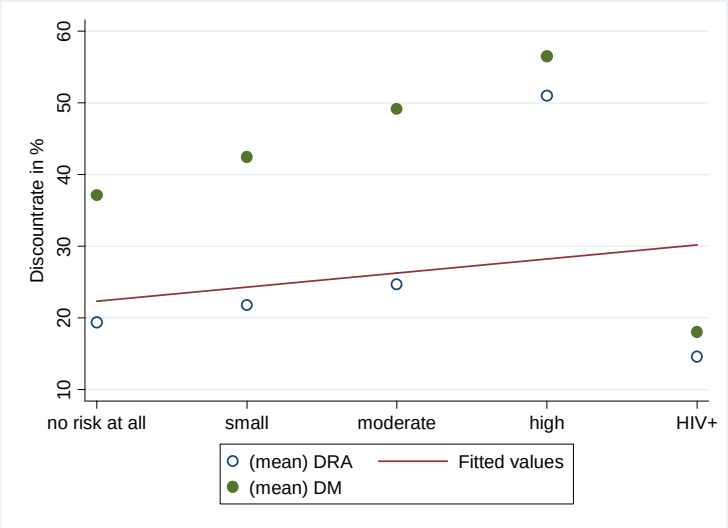
Perceived HIV contraction risk	N	Mean	Std. Dev.
Group 4: High			
γ	4	0.16	0.11
ρ^M	4	56.51	21.71
ρ	4	50.98	24.63
$\rho^M - \rho$		5.54	
Group 5: HIV+			
γ	9	0.25	0.26
ρ^M	9	18.01	17.31
ρ	9	14.59	14.65
$\rho^M - \rho$		3.42	
All			
γ	90	0.58	0.48
ρ^M	90	39.89	23.14
ρ	90	21.99	21.81
$\rho^M - \rho$		17.91	

Table 7.5 shows that the correction for the "lower-risk group", i.e. the first three groups, is substantial: 20.24 percentage points, which is in line with Andersen et al. (2005), who finds an average reduction of 15.1 percentage points among the Danish population. Furthermore, correcting for utility curvature widens the gap between the group of agents that perceive to be highly at risk of contracting HIV and the other agents, i.e. their discount rate turns out to be relatively high. Finally, it brings the implied rate of time preference of HIV positive agents closer to the lower-risk group. Table 7.5 shows that correcting for risk attitude decreases the estimate of time preference for HIV positive agents with 3.42 percentage points. For the other group this difference is much higher, and ranges between 5.54–24.50 percentage points.

Figure 7.2 shows the average discount rates before (DM) and after correction for risk attitude (DRA) for the 5 different groups. Both sets of points have also been corrected for differential mortality expectations. The figure illustrates the importance of incorporating risk preferences in estimating time preferences. Figure 7.2 does show a trend upwards. The average discount rates for seropositive agents, however, is still lower compared to uninfected subjects, although

not significantly anymore (p-value=0.32). This correction again reduced the discrepancy between the HIV positive group and the group that perceives to be highly at risk (2.12 percentage points), but this difference remains significant (p-value=0.02).

Figure 7.2: Discount rates corrected for mortality (DM) and risk aversion (DRA). Sample with $\gamma \geq 0$.[20]



In summary, the data show that after correcting for mortality and curvature of the intertemporal utility function, agents that perceive to be more at risk of contracting HIV, do display significantly higher rates of time preference as well as lower coefficients of risk aversion. Nevertheless, HIV positive agents still display lower discount rates than those who have not (yet?) contracted the disease. However, this difference is not statistically different anymore.

7.4.3 Discount rate and future income decline

Another possible explanation for the relatively low discount rate for HIV positive subjects (as also suggested in Chapter 6) could be that their expected future budget constraint is expected to be relatively tight compared to other subjects. The analysis so far assumed that the monetary benefits *M* accrued on top of a basically unchanging consumption level. But due to their (known) illness, expenditures will rise for the HIV positive group, and income will most likely fall (see Chapter 3 for a more extensive discussion). In that case, significant differences in marginal utility may occur between the two points of time over which the

[20] Regression line through data points of the implied discount rate corrected for mortality and risk attitude (DRA).

experiment was conducted.[21] If anticipated differences in future *marginal utility* are not fully eliminated by higher savings, the imputed discount rate will be lower than the true degree of time preference.

Assume that utility of future consumption is specified by $U(C)=\frac{C^{1-\gamma}}{1-\gamma}$, $U'(C)>0$, $U''(C)<0$. Using future marginal utility over current marginal utility to make future goods comparable to current goods, an estimate for the implied discount rate ρ is obtained as specified in the following equation:

$$\rho=\left[\frac{S_{t+k}}{S_t}\frac{M_{t+k}}{M_t}q_{t+k}^{-\gamma}\right]^{1/k}-1 \qquad (7.9)$$

$$\text{where } q_{t+k}^{-\gamma}=\frac{U'(C(t+k))}{U'(C(t))}=\left(\frac{C(t+k)}{C(t)}\right)^{-\gamma}$$

where q_{t+k}, the relative future consumption level (see Annex 7.3 for the analytical derivation). Assuming a nonnegative intertemporal substitution parameter, γ, the implied discount rate ρ is decreasing in both q_{t+k} and γ. Further assume that the relative price of future consumption is different for HIV positive agents, but equal for all agents in each risk group.

Of course, q_{t+k} cannot be observed directly. But, experimental results for students with and without medical insurance are available. If anticipated future medical costs are the reason for anticipating lower future consumption, it can be assumed that q_{t+k}=1 for those with medical insurance, since they will have their medical bills covered.[22] The uninsured HIV positive group (NI) realistically enough estimated their own time until death 6.5 years lower than the insured HIV positive group (I) ($E_0^I(T_D)$=37.5 vs. $E_0^{NI}(T_D)$=31.0, p-value=0.38). Surprisingly, uninsured HIV positive subjects are on average slightly more risk-averse, although not significantly (γ^I=0.14 vs. γ^{NI}=0.29, p-value=0.65). Not infected uninsured subjects,

[21] Olson & Baily (1981) already stress that differences in marginal utility over time should be excluded from the definition of pure time preference.

[22] Note that q_{t+k}, defined as the relative future consumption level, does not contain the possible expected income decline due to HIV infection. No data are however available to correct for an expected fall in income.

however, do display significantly higher risk aversion (γ^{I}=0.73 vs. γ^{NI}=0.53, p-value=0.04). In the total sample, 32.1% of the subjects were having medical insurance. Among nonwhites, the percentage was significantly less, 22.2% vs. 87.5%. The experimental data indeed show that HIV positive subjects having medical insurance (30.4% of the sample) have substantially higher discount rates than uninsured HIV positive subjects:[23]

$$\rho^{I}=29.82 \text{ vs. } \rho^{NI}=10.24, \text{ p-value}=0.14$$

This difference enables estimating the anticipated decline in consumption *q*. Assuming that uninsured have the same pure rate of time preference as insured participants, one can derive an estimate of the anticipated decline in consumption, *q*, from the difference in observed discount rates (see Annex 2.3):

$$\hat{q}_{NI}=\left(\frac{1+\rho_{NI}^{obs}}{1+\rho_{I}^{obs}}\right)^{\frac{1}{\gamma_{NI}}} \tag{7.10}$$

where $\rho^{i}, i \in \{I, NI\}$ is the discount rate corrected for mortality differences and curvature of the utility function, for respectively insured and uninsured subjects (cf Equation (7.8)).

This procedure yields an estimate of $\hat{q}_{NI}$=0.66, which is, interestingly enough, very close to the findings of Steinberg et al. (2002). They empirically show that in South Africa, HIV households spend a significant part of households' expenditures on medical treatment, on average 34%. This corresponds to the same *q*-value of 66%. Using the same dataset Chapter 4 empirically showed that HIV+ students save more than respondents who are not infected, and those without insurance more than those with insurance. Apparently they do not save enough, however, to fully arbitrage expected marginal utility differences. [24]

Incorporating this anticipated decline in future consumption for uninsured HIV positive participants increases the estimated rate of time preference of HIV positive subjects by 14.64

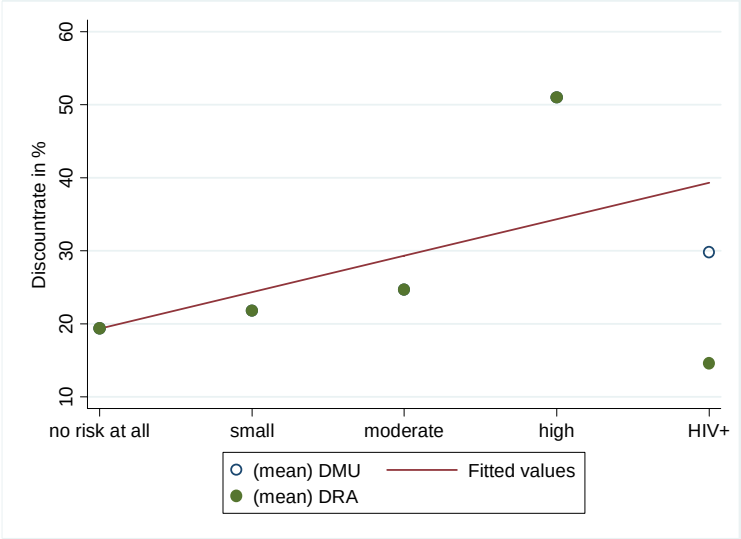
[23] These discount rates are already corrected for mortality and risk attitude as described in the previous subsections.

[24] The *q*-value for the other groups could not be computed, because of the anomaly found that the discount rate for the uninsured in group 2 to 4 is lower and the expected life time of the uninsured of group 2 and 4 is higher than for the medically insured in these groups.

percentage points compared to the discount rate with corrections for mortality only. The rate of time preference for both the seropositive group and the high-risk group are now higher than those obtained for the lower risk groups.

The discount rate for the high-risk group is in fact strikingly higher than the rates found for all groups, even (though insignificant) the one for the HIV positive group. This may be explained by the fact that the HIV positive group probably does not exclusively consists of people who belonged to the high-risk group before their infection. Less risky behavior lowers the chance of getting infected, but not to zero, since there are various other ways of transmission which may not be related to risky behavior, and anyhow less risky behavior reduces risk but does not always reduce it to zero. After this correction, the implied discount rate of the seropositive group now fits in a pattern of time preference rising with perceived risk exposure. Figure 7.3 shows the average discount rates before (DRA) and after the correction for marginal utility (DMU). The slope becomes steeper (+5.01), although it remains insignificant (p-value=0.26).

Figure 7.3: Discount rate corrected for mortality, risk attitude (DRA), and relative future consumption level (DMU). Sample with $\gamma \geq 0$.



To summarize, uninsured HIV positive subjects seem to consider the fall in future marginal utility due to expected illness costs when prizing future benefits. Correcting their discount rate for differences in mortality risk, risk attitude, and the difference in anticipated future marginal utility substantially increases the estimated rate of time preference of HIV positive

subjects. These corrections reverse the earlier result that found them having a significantly lower rate of time preference than the other groups. After corrections, that is not the case anymore.

7.4.4 Correcting for quasi-hyperbolic discounting

There is evidence that people, when choosing between options having both short-run and long-run consequences, tend to overvalue short-run consequences and downplay long term costs, for example in unprotected sex (O'Donoughue & Rabin (2000)). The experimental data also allow for testing this hypothesis of quasi-hyperbolic discounting because subjects were randomly assigned the choice between two alternative testing scenarios, differing only because of a time shift of one month in all the choices offered.[25]

There is another reason to check for quasi-hyperbolic discounting. The subjects within each group were randomly assigned to the delay treatment, so in principle the difference in task should not have a significant effect when comparing average discount rates between groups, as done so far. However, the assignment procedure had as unfortunate outcome that in both the HIV positive group and the high-risk group, only one respondent was assigned the treatment with immediate gratification. Analysis of group averages, and in particular the results for these two groups, could therefore still be biased by a quasi-hyperbolic discounting effect, if there is any, since the delayed option (FED) experiments were overrepresented in that group.

An analysis of the means of the "raw" data (implicit rates of time preferences *not* corrected for differential mortality risk or curvature of the utility function) seemingly supports the hyperbolic discounting hypothesis. Chapter 6 finds that on average respondents were more impatient when choosing between immediate and postponed gratification than when choosing between two delayed gratifications, holding the time span constant. Based on the slightly smaller data set in this chapter, for the longest time horizon experiments (23 months) the difference in the mean discount rate is 12.49 percentage points and is also statistically significant: the Mann-Whitney test indicates that the two sample are not drawn from the same distribution (p-value=0.02).

[25] The analysis is again restricted to subjects with a nonnegative risk parameter.

However, replicating the analysis *after* correcting for both mortality and curvature of the utility function as described in Subsection 7.4.2 changes the results. The difference between estimated rates of time preference of the group with and without delayed gratification then turns out to become both much smaller and insignificant (Δ=3.40, p-value=0.71). Apparently, ignoring mortality risk and curvature of utility in the calculation of time preference biases the test for quasi-hyperbolic discounting. Testing within each risk group, using the specification of the quasi-hyperbolic discount functions suggested by O'Donoghue & Rabin (1999) does not lead to different conclusions: quasi-hyperbolic discounting is rejected for all subgroups.

The conclusion seems clear: Although on direct estimates of discount rates, the test for quasi-hyperbolic discounting is accepted, that result evaporates once corrections for between-group-differences in mortality, attitudes towards risk, and anticipated future consumption decline are incorporated in the estimation of the discount rate ρ. It is therefore not necessary to further correct the estimates of time preference for the treatment effect in analyzing the relation between time preference and perceived HIV contraction risk.

7.5 Conclusion

This paper studies whether risky behavior leading to increased HIV contraction risk can be explained by risk and time preferences. Since unsafe sex increases the risk of getting infected, intuitively the more risk-averse one is, the more one should be willing to take precautions to reduce infection risks. Equally, unsafe sex trades off current benefits against future costs; thus the more one discounts the future, the less weight one attaches to avoiding those costs.

Using raw data from economic experiments with real monetary rewards, this chapter finds that risk aversion is significantly and negatively related to perceptions of HIV contraction risk. However, no such relation is found for raw estimates of time preferences. While risky sexual behavior is correlated with higher discount rates, HIV positive respondents seemingly but paradoxically displayed significantly more patient behavior in choosing between present and future payment options than all other groups considered.

However, the assumption that the pure rate of time preference is the only factor entering the pricing of future benefits, though commonly made in the experimental literature, is limiting and biased the results. Therefore, this paper considered other factors entering the relevant

discount rate when estimating time preferences. Incorporating differences in perceived mortality risk, risk attitude and anticipated changes in marginal utility of consumption over time, reverses the initial finding that HIV positive respondents would have significantly lower discount rates than the other groups. The applied corrections decreased the discrepancy between the discount rates of the high-risk group and the HIV positive group by 17.9 percentage points and is no longer statistically different. The estimates now show the expected distinct positive relation between discounting and perceived exposure to contracting HIV. Applying the corrections thus seems to solve the paradox.

The experimental data also allowed the estimation of the decline in future consumption levels that HIV infected respondents expect. This estimate is similar to what Steinberg et al. (2002) report on the share of medical expenses in total consumption of HIV affected households. Although Chapter 4 finds higher saving rates among HIV positive respondents than in the rest of the sample, HIV positive respondents apparently do not save enough to significantly offset anticipated future declines in consumption opportunities.

This chapter thus shows that superficial analysis of time preferences, i.e. without correcting for other factors relevant in the pricing of future benefits, can be very misleading when comparing different risk groups in society. In particular, it shows the importance of differences in expected mortality, risk attitude and expected increases in marginal utility of consumption over time. The relevance of this work should be clear given the current trend of conducting experiments in the field.

In conclusion, risk and time preference not only have an impact on risky sexual behavior, but they are also related to perceptions of HIV contraction risk. In addition, estimations for the average infection probabilities based on perceptions of remaining lifetime are close to the actual HIV prevalence rate in South Africa at the time the experiments were conducted. Moreover, Chapter 6 also showed that awareness in the student sample is high. The experimental data thus suggest that the respondents do not continue to practice with unsafe sex because of ignorance, but because they are less risk-averse and value the future less than those that do not. Accordingly, prevention focused on education alone is likely to be insufficient.

However, even accepting that risky behavior reflects risk preferences and low rate of time preference rather than ignorance about risk factors, their behavior may still be privately suboptimal if they underestimate the total expected illness costs. Since for three out of the five risk groups the average expected lifetime is higher for the medically uninsured sub-samples, this indeed suggests that although individuals are aware of HIV contraction risk itself, they seem to underestimate the consequences of HIV infection, such as the costs and need for medical treatment. Therefore, providing information about the actual illness costs might be another useful action to deter individuals from risky sexual behavior. Another option would be to try to change individuals' preferences, but that strategy would invalidate the assumptions of normative analysis where preferences are considered as given.

Finally, since there are high social costs attached to HIV/AIDS, intervention seems justified even if individuals are fully informed and act privately optimal. Considering the high time preferences found in this chapter, offering monetary incentives might be necessary to tilt the intertemporal tradeoff implicit in choosing to practice unsafe sex towards the safe sex option. An example of such an incentive would be free distribution of condoms, as part of the campaign to prevent the further spread of HIV. Clearly this measure alone is unlikely to be enough, since the students in the sample already had easy access to free condoms at the campus.

Annex 7.1: Corrections for mortality

Suppose agents have an annual survival probability $S_{t+k} = p^{k-t}$ of surviving period $t+k$, where p is the probability of surviving to the next period. Equation (7.11) then shows the relative weight an agent attaches in period t to her well-being in period $t+k$ corrected for mortality from which agents' unconditional discount rate ρ^{uc}, i.e. not conditioned on the survival rate, can be elicited.

$$\left(\frac{1}{1+\rho^{uc}}\right)^{k} = \frac{S_{t+k}}{S_t(1+\rho)^{k}} \tag{7.11}$$

where ρ the discount rate conditional on his survival function S_{t+k}. Assuming constant survival probability, the probability of dying in year k is $f(k) = p^{k}(1-p)$ such that from the expected time of death measured at time 0, $E_i(\hat{T}_D) = Lex_i - Age_i$, the probability of survival to the next period, p can be solved using the general formula of Equation (7.12) for a converging infinite arithmo-geometric series, i.e.:

$$\sum_{k=0}^{\infty}(a+kr)q^{k} = \frac{a}{1-q} + \frac{rq}{(1-q)^{2}} \tag{7.12}$$

$$\begin{aligned} E_k(T_D) &= \sum_{k=0}^{\infty} f(k)k = \sum_{k=0}^{\infty} p^{k-1}(1-p)k = \frac{1-p}{p}\sum_{k=0}^{\infty} p^{k}k \\ &= \frac{1-p}{p}\frac{p}{(1-p)^{2}} = \frac{1}{1-p} \\ \Rightarrow p &= \frac{E_k(T_D)-1}{E_k(T_D)} \end{aligned} \tag{7.13}$$

Substituting (7.13) in (7.11) and solving for the conditional discount rate, provides the discount rate conditional on the discrete survival function, specified in Equation (7.14).

$$\rho = (1+\rho^{uc})p - 1 \tag{7.14}$$

Annex 7.2: Corrections for risk attitude

Consider two certain monetary outcome M_t and M_{t+k} at time t and $t+k$. An individual is indifferent between these two monetary outcomes if Equation (7.15) holds.

$$U(M_t) = D(k)U(M_{t+k})$$
$$\text{where } U(M_t) = \frac{M_t^{1-\gamma}}{1-\gamma} \text{ and } D(k) = \frac{1}{(1+\rho^{mc})^k} \tag{7.15}$$

In this specification, the initial assumption that individuals are risk-neutral in intertemporal choices is dropped such that $\frac{\partial U(M_t)}{\partial \gamma} \geq 0$ if $\gamma \geq 0$. Combining Equation (7.15) and (7.11) results in the Equation (7.16):

$$\frac{S_t M_t^{1-\gamma}}{1-\gamma} = \frac{1}{(1+\rho)^k} \frac{S_{t+k} M_{t+k}^{1-\gamma}}{1-\gamma} \tag{7.16}$$

Solving for ρ provides us with the for mortality and risk attitude corrected discount rate:

$$\rho = \left[\frac{S_{t+k}}{S_t} \left(\frac{M_{t+k}}{M_t} \right)^{1-\gamma} - 1 \right]^{1/k} \tag{7.17}$$

Annex 7.3: Corrections for differences in anticipated future consumption levels (for HIV positive group only)

Assume again that individuals have a nonnegative risk parameter $\gamma \geq 0$ and that their utility is specified by $U(C) = \frac{C^{1-\gamma}}{1-\gamma}$, where $U'(C) = C^{-\gamma} > 0,\ U''(C) = -\gamma C^{-\gamma-1} < 0$ if $\gamma > 0$.

Assuming that, for people who are actually infected by HIV positive, the impact on marginal utility of anticipated consumption decline is substantially larger than the impact of differences in monetary rewards, the latter can be ignored and a standard expression for the consumption discount factor (CDF) can be used to compare current and future award benefits:

$$CDF = \frac{U'(C_{t+k})S_{t+k}}{U'(C_t)S_t(1+\rho)^k} \tag{18}$$

Using (18) in the equation indicating when agents are indifferent between an award at *t* and an award at *t*+*k*, yields:

$$S_t M_t = \frac{1}{(1+\rho)^k} S_{t+k} M_{t+k} q_{t+k}^{-\gamma}$$
$$\text{where } q_{t+k}^{-\gamma} = \frac{U'(C(t+k))}{U'(C(t))} = \left(\frac{C(t+k)}{C(t)}\right)^{-\gamma} \tag{19}$$

in which q_{t+k} the relative future consumption level, ρ is the discount rate. Solving for ρ provides the rate of time preference corrected for mortality and different marginal utility over time.

$$\rho = \left[\frac{S_{t+k}}{S_t}\frac{M_{t+k}}{M_t} q_{t+k}^{-\gamma}\right]^{1/k} - 1 \tag{20}$$

Assuming a nonnegative intertemporal substitution parameter γ, ρ is decreasing in both q_{t+k} and γ:

$$\frac{\partial \rho}{\partial q} = \frac{\partial \rho}{\partial \gamma} = -\frac{\gamma}{k}\frac{S_{t+k}}{S_t}\frac{M_{t+k}}{M_t} q_{t+k}^{-\gamma-1} < 0 \tag{21}$$

Assuming that the relative price of future consumption is different for HIV positive agents, but equal for all agents in each group, ρ can be estimated if the value of q_{t+k} is known. Assuming in addition that differences in the relative future consumption level between insured (I) and not insured (NI) HIV positive individuals are only caused by expenditures for medical consumption and that insured and uninsured HIV positive agents have the same pure rate of time preference, $\hat{q}_{NI}$ in Equation (22) would provide an estimate for the relative future consumption level of uninsured HIV positive individuals with respect to insured HIV positive individuals:

$$\left.\begin{aligned}\rho_{NI}^{act} &= (1+\rho_{NI}^{obs})q_{NI}^{-\gamma_{NI}} - 1 \\ \rho_{NI}^{act} &= \rho_{I}^{act} = \rho_{I}^{obs}\end{aligned}\right\} \rho_{I}^{obs} = (1+\rho_{NI}^{obs})q_{NI}^{-\gamma_{NI}} - 1 \Rightarrow$$

$$\hat{q}_{NI} = \left(\frac{1+\rho_{NI}^{obs}}{1+\overline{\rho_{I}^{obs}}}\right)^{\frac{1}{\gamma_{NI}}} \tag{22}$$

Where $\overline{\rho_{I}^{obs}}$ is the average of the for mortality and risk attitude corrected discount rate of insured HIV positive subjects as defined in Equation (7.17) and ρ_{NI}^{obs} is the for mortality corrected discount rate as defined in Equation (7.14).

Annex 7.4: Summary tables

Table A7.1: Definitions and slopes of regression lines (group 1 to 4 in brackets).

	Definition of discount rate	**Slope (all)**		**Slope ($\gamma \geq 0$)**	
		all	p-value	$\gamma \geq 0$	p-value
D	Unconditional discount rate	-3.93	0.26	-2.51	0.67
		(0.93)[26]	*(0.37)*	*(+6.63)*	*(0.01)*
DM	Discount rate conditioned on survival	-3.82	0.27	-2.42	
		(+1.04)	*(0.14)*	*(+6.47)*	*(0.00)*
DRA	Discount rate conditioned on survival and risk attitude			+1.97	0.73
				(+9.77)	*(0.14)*
DMU	Discount rate conditioned on survival, risk attitude (group 1 to 4), and differences in marginal utility for group 5 based on discount rate of insured HIV+ subjects (q=0.55)			+5.01	0.26
				(+9.77)	*(0.14)*

Table A7.2: Differences in discount rate for group 4 and 5. Sample $\gamma \geq 0$.

	D	DM	DRA	DMU
Group 4	58.33	56.51	50.98	50.98
Group 5	18.62	18.01	14.59	29.23
Δ	39.71	38.51	36.38	21.75
p-value	0.0008	0.0009	0.02	0.13
Δ reduction		1.20	2.12	14.64
Total reduction				17.9

[26] Slope of regression line, when considering only group 1 to 4.

Chapter 8

Summary and Conclusion

8.1 Summary

After its discovery in the late 1970s, the AIDS epidemic has continued to exceed all expectations in terms of both size and impact. In 2005, an estimated 39.5 million people are living with HIV worldwide and over 25 million had already died of AIDS related diseases. Swaziland leads the ostensibly limitless world rankings, having over one third of its adult population infected. It is undisputable that households carrying an HIV infected person or that have lost the main income earner due to AIDS are coping with the most severe consequences of the disease. They are not only forced to face the health and psychological aspects of the disease, like physical decay, strong medication with demanding complicated regimes, caring for the AIDS-sick family member, stigmatization, and grief after demise, but in these difficult circumstances they must also overcome severe problems of an economic nature. The disease prevents fulltime work and limits continued labor market participation. In developing countries, where a large part of the population already lives in poverty, and where well-functioning social security systems rarely exist, this often implies a fall in an already meager income together with significant increases in indispensable medical care expenses. This dissertation studied how households cope with this changed economic situation. It addressed the question of whether the sketched situation forces households to take financial

precautions, like additional saving, *before* infection takes place or *before* the increased expenses and reduced income actually arise. In other words, are households adapting their economic behavior to be able to limit the economic impact of HIV?

In the hardest hit countries, clearly it is not only HIV affected households that carry the burden of the epidemic. Whole societies are disrupted. Companies, for example, are exposed to high absence rates, and reduced productivity caused by physical and emotional stress, reducing the effectiveness of investments. Governments are confronted with an increased need for expenditures on health and social benefits, while at the same time the tax base is eroded. In these circumstances, households can only reckon on limited government support. Moreover, it is expected that economic growth is dampened, which further decreases the possibilities of governments to support these households. Surprisingly, macro- empirical studies measuring the economic impact of HIV/AIDS find ambiguous results. These divergent findings ask for an explanation. Micro-level research, currently rather unexplored, could provide insight into the following questions. Are current studies based on different, among which also wrong, assumptions? Is HIV/AIDS only affecting isolated parts of society, while other parts benefit, such that the aggregate impact is limited? Or do adaptation mechanisms exist at the micro level that limit the expected negative economic impact at the macro level?

This dissertation aimed to contribute to the exploration of the latter question, that is, are microeconomic processes or behavioral changes taking place that reduce the dreaded macroeconomic impact of the epidemic? Could these processes and behaviors be stimulated? The research focused on the question of how the AIDS epidemic influences the economic choices of households over time and studied their saving behavior in particular. The literature discussion in Chapter 3 showed that the economic consequences for families with an infected household member are large. In countries where few are covered by medical insurance and many live in poverty, this raised the question of what specific strategies households could employ to cope with a possible health shock like HIV/AIDS. Additional saving, for example, enables households to pay for better medical care, resulting in more continued labor market participation. Households would in this case not only be better able to bear the economic consequences of an HIV infection, but the side-effect of continued labor market participation would be a reduction in the negative impact on economic growth. This argument posed the main research question of this study: Do individuals anticipate the economic costs related to

possible HIV infection by incrementing savings? In answering this core question, this study followed different routes, using theoretical, empirical, as well as experimental methods. This dissertation not only analyzed the economic behavior of HIV infected people, like many existing micro-empirical studies, it especially focused on the behavior of individuals who are not (yet) infected. After all, the *perception alone* of the risk of contracting HIV during one's lifetime may influence economic behavior. Therefore this study also addressed the issue of whether individuals who perceive themselves to be at risk actually are at risk by analyzing their sexual behavior. Part I of this thesis expounded the main ideas behind this research, provided the main facts on the disease, and presented an overview of the related literature.

For the theoretical framework, this dissertation used a two-period lifecycle model, which assumes that individuals smooth consumption over the lifecycle. HIV/AIDS influences this process both directly and indirectly; directly, through the negative impact on productivity when infected, resulting in lower income, and indirectly, through an increase in mortality risk and expenditures on medical treatment, which are necessary to keep the disease under control. This study analyzed these indirect effects in particular. Although the insights found in the literature on HIV/AIDS and intertemporal choice include the effects of reduced longevity, how perceptions of both mortality and illness risk and its attended health costs influence these choices is rather unexplored. In any case, saving behavior is underrepresented in the studies on the economics of HIV/AIDS, given that it is saving behavior that is one of the means by which households can independently cope with income shocks, such as the ones caused by HIV/AIDS. People can namely save in many ways, both formally and informally, which could thus be an alternative in countries with limited or inaccessible financial and medical insurance markets. Of course, saving is only possible when income is above the subsistence level.

For the empirical and experimental framework, an experimental study was conducted among students in South Africa. The study was exclusively designed to examine the research questions addressed in this dissertation. South Africa has been facing high HIV prevalence rates for many years, which enabled evaluating possible individuals' responses accordingly. Data on individual characteristics, financial and sexual behavior was supplemented with estimates of the individual risk and time preferences. Risk aversion was measured by offering the respondents a list with ten choices between two possible lotteries. One lottery was riskier than the other, and the chance of payment of the price of the risky lottery increased over the

ten choices. Having a certain level of risk tolerance, the respondent chose at a certain moment for the riskier lottery if the expected payoff was large enough. The exact point of transition determined the individual level of risk aversion. For the measurement of time preferences, a similar method was applied. The respondent was asked to choose between a certain amount to be received in the present or a higher amount in the future, for example one year later. The list included twenty different choices where the future amount was increasing. When the future amount was high enough, the respondent switched to the future amount. The moment of transition provided a measure for the individual time preference. Monetary incentives were used to observe true behavior.

8.2 Conclusions

This thesis found evidence that the AIDS epidemic influences the individual saving behavior of both infected and uninfected individuals. It thus seems to be the case that households adapt their economic behavior to be able to limit the economic impact of HIV/AIDS. These microeconomic behavioral changes may be a reason for the findings of both a limited impact and divergent effects of HIV/AIDS prevalence on economic growth.

8.2.1 Part II: Theoretical model

Chapter 4 showed both theoretically and empirically that saving behavior is influenced in at least two opposing ways: on the one hand increased mortality risk lowers the amount individuals save, and on the other hand HIV infection or perceived infection risk increases their savings. Although HIV infection substantially reduces life expectancy, the data showed that the positive effect of the perceived infection risk or of being seropositive dominates. Additionally, savings of medically insured individuals that perceived a significant HIV contraction risk were enhanced as well. This finding indicates that the respondents not only anticipated the medical costs, but also foresaw other types of income shocks (for example, an expected fall in income due to reduced productivity). The empirical results of Chapter 4 suggest that in a society where the population is confronted daily with diverse aspects of the AIDS epidemic, individuals adapt their saving behavior to the uncertainties that the epidemic engenders, like premature mortality, medical costs, and a fall in income. In this thesis, the phenomenon that individuals in societies confronted with HIV anticipate possible HIV infection by raising the amount of savings is called the "*HIV anticipatory saving motive*". Obviously savings are only enhanced whenever individuals are aware of the illness risk and the additional related costs they might face.

Chapter 4, however, did not show how the epidemic influences the aggregate savings of a country. As was just mentioned, awareness of the contamination risk and the consequent costs is the clue to an increase in savings. This does not only vary from person to person, but is also related to the stage of the epidemic. In an early stage, when HIV incidence is low, there is little awareness and savings will thus be influenced differently than in later stages in which every member of society is confronted daily with the disease or its consequences. Therefore, Chapter 5 considered how aggregate savings evolve over the different stages of the epidemic. The chapter extended the two-period lifecycle model of Chapter 4 by incorporating differences in the level of awareness and in doing so it distinguished between people based on their test status. The extended model predicts a non-monotonic relationship between the different stages of the AIDS epidemic and country's aggregate savings. In an early stage of the epidemic, when the disease is relatively unknown, seropositive-tested individuals will have less of an incentive to save, because the increased mortality risk decreases the expected utility of consumption at old-age. In such a stage, aggregate savings in a country are expected to fall. This is exactly in line with the negative effect that Bonnel (2000) found in his cross-country study making use of data from the early stage of the epidemic. Savings only start to increase when individuals start anticipating both the contamination risk as well as the economic consequences of the disease. The model showed that in this stage, savings could even increase relative to the pre–epidemic level. The awareness-process was modeled by varying the intensity of diagnostic testing. Only when this intensity and the utility of medical consumption compared to regular consumption were high enough, then savings in a country hit by HIV/AIDS would rise. In view of the necessity for medication, the second condition was easily met. In this model it was assumed that infected people die prematurely, making HIV positive tested people spread their income over a shorter period of time and start dissaving relatively early. That is why the model predicted that savings would decline again in a very extensive epidemic, when a relatively large part of the population carries the virus. The increased mortality risk amplified this reduction.

The negative impact on savings in the first period arose from incomplete information. Since the model predicts that savings increase when the testing intensity is increased, this could be a policy instrument for stimulating individuals to anticipate possible infection. For that reason Chapter 5 also analyzed whether expanding diagnostic testing would not only increase savings, but would also improve welfare. Raising the testing intensity in a later phase of life would indeed lead to an improvement in social welfare. Awareness of HIV status, both

positive and negative, enabled individuals to efficiently distribute income over their lifetime and allowed HIV positive individuals to buy the appropriate medical consumption. Also expanding testing facilities in an early phase of life enabled individuals to distribute income more efficiently. Seropositive-tested individuals did not need to unnecessarily save for consumption at old-age. On the other hand, the chapter incorporated additional effects of HIV status knowledge. In particular, being diagnosed as HIV positive could lead to non-economic negative consequences, such as the fear of dying, or being stigmatized. If these negative side-effects are strong enough, extending testing intensity could possibly affect welfare negatively. Because the model postulated a "longevity" insurance in which individuals that are tested HIV negative could not participate, simply because disbursement would otherwise have occurred with certainty, the welfare effect of extending diagnostic testing for HIV negative individuals in an early phase of life appeared to be ambiguous. Although negatively tested individuals did not face mortality risk in the first period of life, enabling them to efficiently distribute income, their income in the second period of life was relatively low. This was due to the fact that they could not benefit from the disbursement of the longevity insurance that they would have had received if they had remained untested. Nevertheless, this chapter also showed that people dissave when mortality increases and save additionally if the HIV contamination rate is large. Moreover, it showed that diagnostic testing could be welfare improving.

8.2.2 Part III: Experimental approach

The influence of the HIV anticipatory saving motive in a country depends on the perceived HIV contraction risk, as was introduced in the first part of this thesis. However, it also depends on individual risk and time preferences. Moreover, the latter two may be related to the actual HIV contamination risk. Risk-averse individuals may take financial precautions more easily than risk-loving individuals. Additionally, individuals that are more forward-looking will be more inclined to anticipate the costs of illness that may come up in a later stage of life. Risk and time preferences influence sexual behavior as well, which further complicates the relation with saving behavior. Chapter 6 analyzed these relations using the experimental data that was collected among students in South Africa.

The empirical results showed that sexually-experienced participants are considerably more risk-tolerant than participants lacking sexual experience. The data, however, did not show a relation between risk attitude and condom use. Considering risk attitude sec, having sexual

experience in countries with a high HIV prevalence rate seemed to be a venture in itself. That is, risk-averse participants appeared to view abstinence as an alternative to using condoms in preventing the contraction of the virus, while risk attitude did not materialize in the choice whether or not to use condoms. Participants that were tested HIV negative appeared to exhibit more risk-averse behavior. The diagnosis thus seemed to reflect their risk behavior. Participants that had never been tested, exhibited on average less risk-tolerant behavior compared to those that had been tested. Consequently, the results of this study showed that offering voluntary testing is likely to attract a disproportionately large percentage of (HIV negative) risk-avoiders.

The literature showed that HIV infection entails great expenses in the future. These costs, however, are relatively small for people with a high rate of time preference, in other words for people who are more present-oriented. Therefore, one might expect that individuals with a high rate of time preference would exhibit riskier sexual behavior than people with low time preferences. Indeed, Chapter 6 showed that after correcting for socio-economic background and HIV awareness, both sexually experienced individuals and individuals that reported to have unsafe sex displayed significantly higher discount rates. Hence, unsafe sex appeared to be partly an economically explicable choice belonging to individual risk and time preference.

Both HIV positive participants, as well as participants with high-perceived contamination risk, the so-called "high-risk group", displayed considerably less risk-averse behavior. Assuming that their risk behavior is translated into their sexual behavior, this would subscribe to their perceptions of HIV contraction risk. Moreover, this high-risk group appeared to have characteristic individual risk and time preferences that mitigate the HIV anticipatory saving motive: specifically the group that *should* anticipate HIV infection more will proportionally do so to a lesser extent. Although the high-risk group is more present-oriented, the HIV positive group appeared to be more future-oriented than all other considered groups, i.e. the estimated mean rate of time preference was significantly lower. This is a remarkable result for two reasons: first, the data showed that higher discount rates are related to risky sexual behavior. Besides, expected lifetime is eminently shorter, which would stimulate present-oriented behavior. Due to the lack of panel data, behavioral changes could not be evaluated. However, based on the perceptions of HIV contraction risk, these initial results did suggest that time preferences change after becoming diagnosed as HIV positive.

The striking finding of Chapter 6 was further analyzed in Chapter 7. The assumption that the pure rate of time preference is the only factor entering the pricing of future benefits was dropped and time preferences were estimated again while correcting for differences in mortality and risk attitude. After integrating these other factors, which proportionally reduced the estimations for the rate of time preferences of the other groups, HIV positive participants on average still displayed a significantly lower discount rate compared to the high-risk group. However, their discount rate was no longer significantly lower than the low-risk groups.

Further analysis of the data showed that seropositive participants having medical insurance displayed higher time preferences than uninsured seropositive participants did. Chapter 7 explained this result by arguing that the measured individual discount rate also includes perceptions of future consumption levels. Under this assumption, the expected consumption level for HIV positive individuals over a two-year period was calculated resulting in an estimate of 66% of the current consumption level. This finding, solely based on experimental data, corresponds to the decline that Steinberg et al. (2000) had measured in their empirical research among HIV households in South Africa. The HIV anticipatory saving motive of the HIV positive group does thus not only appear to reveal itself in the total amount they save, but also in the measured discount rate of those that were uninsured. Apparently, they did not save enough to offset the expected decline in future consumption level and used the experiments as an opportunity to supplement their current savings.

Although the uninsured HIV positive group considered the expected decline in consumption level in valuing future benefits, the high-risk group did not seem to consider this decline. It could possibly be that their savings were already sufficient to anticipate the expected illness costs. However, since they seemed to underestimate the lifetime prolonging impact of medicines, it is more likely that they also underestimated the economic consequences. They did, however, consider their life expectancy realistically lower than the low-risk groups. In general, HIV awareness in the sample was high; more than half of the students considered HIV contraction risk for other students to be high and almost 80% ranked HIV/AIDS as the number one cause of death in their province. Moreover, estimations for the average infection probabilities based on perceptions of remaining lifetime were close to the actual HIV prevalence rate in South Africa. Improving awareness of the economic consequences seems to be a natural next step.

After applying the last correction, the discount rate of the HIV positive group was no longer statistically different from the high-risk group. Furthermore, the corrected estimations showed the expected distinct positive relation between perceived exposure to contracting HIV and time preferences. HIV infection thus changes the pricing of future benefits, in other words the discount rate, but not, as was initially suggested by the raw estimates, the individual rate of time preference.

Considering the high social costs attached to HIV/AIDS, intervention seems justified even if individuals are fully informed and act privately normal. Since risky sexual behavior is associated with high risk and time preferences, changing these preferences could contribute to preventing the further spread of HIV. This is not at all easy, since risk and time preferences are notably developed during early childhood (Maital & Maital, 1977), and this strategy would cross the threshold between normative and positive analysis. However, given individual's risk and time preferences, prevention focused on increasing knowledge of the total expected costs of risky sexual behavior could already limit risky sexual behavior. Furthermore, offering monetary incentives might be necessary to tilt the intertemporal tradeoff implicit in choosing to practice unsafe sex towards the safe sex option. For example, free distribution of condoms, that lower the present costs of safe sex, could be a useful tool in prevention campaigns.

8.2.3 Methodological issues

Although not core questions of this thesis, some methodological issues were addressed. Firstly, the experimental methods resulted in a relatively high frequency of multiple switching compared to previous studies conducted in western countries. The switching appeared more often in the risk-aversion tasks. Part of the switching could be explained by individual preferences, being indifferent over a certain interval of options, but another part was likely due to misunderstanding the tasks. Computerized experiments measuring risk and time preferences often force one switching-point. This study suggests that real preferences cannot be revealed when no option of being indifferent between the two alternatives is offered.

Secondly, Chapter 7 showed that conclusions based on discount rates estimates which fail to incorporate other factors than the pure rate of time preference may be biased. Not only did the discount rate of HIV positive participants not turn out to be an outlier in relation to risk exposure after correction, but the evidence for quasi-hyperbolic discounting that was found in

Chapter 6 based on uncorrected discount rates is also rejected after correcting for mortality and risk behavior.

8.3 Future research

This study answers some questions, but raises some as well. The study finds evidence for the HIV anticipatory saving motive. Awareness of HIV contraction risk appears to augment anticipatory behavior. Two additional questions could, however, be raised in this respect: do households also sufficiently anticipate both direct and indirect costs of HIV infection? In other words, is the increase in their savings enough to cover the total costs of infection? And secondly, is the HIV anticipatory saving motive based on actual risk exposure or is this motive anxiety related? The answer to the first question may be negative for the uninsured HIV positive group. The lower discount rates for this group suggest that their savings are not high enough to offset the expected decline in future consumption level. For the insured HIV positive group and the other risk groups it was not possible to evaluate whether they saved enough with the available data. Following the economic behavior of individuals over more periods by using panel data could provide an answer to this question. The second question could be answered by taking blood samples that could be screened for HIV in follow-ups of this type of experimental research. In this way, it would be possible to identify whether those who perceive themselves to be highly at risk do in fact contract HIV more often than others. Moreover, this information would be more reliable than self-reported sexual behavior and health status.

Another question is raised by the finding that although on average people that perceive to be highly at risk of contracting the virus during their lifetime take financial precautions, still over one third reported to neither have medical insurance nor save. Do these subjects that do not take precautions not consider the economic costs of an HIV infection? Or does their budget not allow them to save or have medical insurance? A deeper analysis of their economic profiles would help to answer this question. A similar question is invited by the fact that among the savers that perceive to be highly exposed to HIV contraction risk only one third had medical insurance. Further analysis could show whether or not they save instead of buying medical insurance, and why this may be the case. Do people prefer savings because of their flexibility? Savings can be used as insurance against many types of income shocks, not only increased medical costs. Or is the preference for savings caused by a lack of trust or quality in local insurance providers? Or is insuring simply too expensive?

With regard to the theoretical part of this study, future research is encouraged to extend the presented theoretical models by incorporating endogenous relations and to improve modeling the effects of HIV/AIDS on intertemporal choice. The theoretical two-period lifecycle models in Part II, for example, do not include the direct effects of an HIV infection on income. Furthermore, the current models include only two periods. Extending these models to more periods or making the model continuous would allow the incorporation of the effects of medicines on productivity and the prolongation of lifetime.

Concerning methodological issues, including an indifference option in the experimental tasks, would improve measuring the preferences of subjects. Omitting the indifference option complicates distinguishing between inability and indifference, when subjects exhibit multiple switching. In follow-ups it would therefore be interesting to analyze the effect of including such an indifference option in the experimental tasks. Moreover, the expected bias resulting from forcing one switching-point should be measured. If switching appears to be largely due to misunderstanding, new methods of measuring risk and time preferences should be developed for less educated samples.

The empirical and experimental results in this study were based on a study among students only. There are three reasons why further extending the research to field subjects is necessary. First, although it was possible to correct for a wide range of socio-economic variables it is important to test the HIV anticipatory saving hypothesis among groups having different educational backgrounds, since it is relevant to know to whether the results can be applied to the South African population in general. In doing so it would be important to address the methodological issues mentioned above. Second, both adaptation mechanisms and risk and time preferences may not only vary with the level of HIV prevalence but also across countries, requiring measuring possible differences across countries. Third, it is important to evaluate whether the empirical and experimental findings on HIV positive participants in this thesis are biased for characteristics that are related to not dropping-out of school when diagnosed HIV positive. Besides these reasons, it would be of interest to analyze whether seropositive individuals attending HIV support groups and receiving counseling behave differently than HIV positive subjects who do not have such support. Councilors may have played an important role in stimulating the anticipatory behavior of infected students.

8.4 Policy recommendations

Based on the main findings of this thesis, and complying with the limitations of this research addressed in the previous section, I cautiously recommend some policy measures to be taken.

People that are aware of the AIDS epidemic include both the mortality risk and the increase in the expected illness costs in their saving behavior. Among high-risk and HIV positive groups, this leads on balance to an increase in individual savings. This increase enlarges the possibilities for these households to face up to the financial consequences of an HIV infection. Saving does not only increase the accessibility for medical treatment. Medical treatment also prolongs labor force participation, dampening the negative impact on economic growth. People that are not sufficiently aware of the contamination risk will insufficiently anticipate the economic risks. These people should thus be informed of the risks they face. There are two possible measures: Intensifying testing, while at the same time carefully dealing with the stigmatization of HIV positive individuals. Since the results of this study showed that offering voluntary testing attracts a disproportionately large percentage of (HIV negative) risk-avoiders, it is recommended to cater to risk-loving behavior in campaigns to recruit people to get tested. Secondly, next to informing people about AIDS and the prevention possibilities in the usual prevention campaigns, campaigns that include a strong emphasis on the *actual* contamination risk and economic consequences are advised.

Risky sexual behavior appears to be an economic choice which depends on individual risk and time preferences. Risk and time preferences that correspond to risky sexual behavior in particular have a negative impact on the HIV anticipatory saving motive. Here the results show that people, who actually should save, will do so to a less extent. It might therefore seem straightforward to aim at changing people's risk and time preferences. This strategy, however, would demand a completely different approach than the usual ones and might not be easy to implement. Moreover, this strategy would invalidate the assumptions of normative analysis where preferences are considered as given. Changing risk and time preferences would, however, have two important effects: it would limit risky sexual behavior, which would reduce the further spread of HIV, and in addition it would stimulate the "HIV anticipating saving motive", so that people that do contract the virus after all are better able to cope with the economic consequences. Based on the results of this study, at least considering development of prevention aimed at influencing these characteristics is therefore

strongly recommended. Another option is the offering of monetary incentives that reduce risky sexual behavior or stimulate safe sex by, for example, the free distribution of condoms. This would also mitigate the further spread of the virus, but this is clearly not enough since the students in the sample already had easy access to free condoms at the campus. Finally, educating people about the true risk of infection and future illness costs would enable them to make an optimal choice in accordance with their preferences.

Medical costs and income shocks are less prominent in western countries with well-functioning social safety nets and the majority of people having medical insurance. In these countries, saving for HIV related costs is less necessary and the HIV anticipatory savings motive will probably be less present. However, this research may still contribute to HIV prevention in these areas as well. This study showed that high risk and time preferences are related to sexual behavior. We should be careful in extrapolating findings based on research among students in South Africa to people in Western countries, since economic behavior is at least partly culturally determined. Still, focusing prevention campaigns more on individuals with these characteristic risk and time preferences may also help reduce the number of infections in these countries. Since HIV infected people in western countries receive relatively more extensive and costly treatment compared to the treatment in developing countries, this might lead to a substantial reduction in the medical costs for society, even though HIV is less prevalent.

This study is one of the first attempts to measure the effect of HIV/AIDS on intertemporal choices. Although many research questions still need to be addressed, it provides some valuable insights which can be useful for designing policies for both preventing the further spread of HIV and improving the economic situation of both HIV affected households and society as a whole.

References

Actuarial Society South Africa (2007). ASSA2003.

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau & E. Elisabet Rutström (2005). "Eliciting risk and time preferences," *Working paper 05-24*, Department of Economics, College of Business Administration, University of Central Florida, USA, forthcoming, *Econometrica*

Ando, A. & Modigliani, F. (1957). "Tests of the life cycle hypothesis of saving: comments and suggestions," *Oxford Institute of Statistics Bulletin*, Vol. 19, p.99−124.

Arndt, Channing & Jeffrey Lewis (2000). "The macro implications of HIV/AIDS in South Africa: A preliminary assessment," *South African Journal of Economics,* Vol. 68(5), p.856−887, December.

Barsky, Robert B., F. Thomas Juster, Miles S. Kimball & Metthew D. Shapiro (1997). "Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study," *Quarterly Journal of Economics*, Vol. 112(2), In Memory of Tversky (1937-1996), p.537−579, May.

Becker, Gary S. & Casey B. Muligan (1997). "The endogenous determination of time preference," *Quarterly Journal of Economics*, Vol. 112(3), p.729−798, August.

Bell Clive, Shantayanan Devarajan & Hans Gersbach (2003). "The long-run economic costs of AIDS: Theory and an application to South Africa," *AIDS Economics*. Washington, DC: The World Bank.

Bickel, Warren K. & Marsch, Lisa A. (2001). "Towards a behavioral economic understanding of drug dependence: Delay discounting processes," *Addiction,* Vol. 96(1), p.73−86, January.

Binswanger, Hans P. (1980). "Attitudes toward risk: Experimental measurement in rural India," *American Journal of Agricultural Economics*, Vol. 62(3), p.395−407, August.

Bloom, David E. & Ajay S. Mahal (1995). Does the AIDS epidemic really threaten economic growth? Cambridge: National Bureau of Economic Research.

Bonnel, René (2000). "HIV/AIDS: Does it increase or decrease growth?," The World Bank AIDS Campaign Team for Africa. Washington, DC: The World Bank.

Bonnerjee, Aniruddha (2003). The impact of HIV/AIDS on social security. Worldbank, HDNSP April.

Booysens, Frederik & Martine Visser (2006). "Demand for health care in HIV/AIDS-affected households in two communities in the Free State province of South Africa," Economic Research Southern Africa. *Journal of Development Studies* (forthcoming).

Campaign for Access to Essential Medicines (2005). "Untangling the web of price reductions: A pricing guide for the purchase of ARVs for developing countries," 8th edition, June, Geneva: Medecines Sans Frontieres. Available at http://www.accessmed-msf.org.

Chapman, Gretchen B. (2005). "Short-term cost for long-term benefit: Time preference and cancer control," *Health Psychology*, Vol. 24(4), p.S41–S48.

Chesson, Harrell W., Jami S. Leichliter, Gregory D. Zimet, Susan L. Rosenthal, David I. Bernstein, & Kenneth H. Fife (2006). "Discount rates and risky sexual behaviors among teenagers and young adults," *Journal of Risk and Uncertainty*, Springer, Vol. 32(3), May, p.217−230.

Coates, Thomas, Olga Grinstead, Steven Gregorich, David Heilbron, William Wolf, Kyung-Hee Choi, Julius Schachter, Peter Scheirer, Ariane Van Der Straten, Munkolekole Claudes Kamenga, Michael Sweat, Isabelle de Zoysa, Gina Dallabetta, Kevin O'Reilly, Eric Van Praag, David Miller, Monica Ruiz, Sam Kalibala, Ben Nkowane, Don Balmer, Francis Kihuho, Steve Moses, Francis Plummer, Gloria Sangiwa, Margaret Hogan, Japhet Killewo, Davis Mwakigile, & Colin Furlonge (2000). "Efficacy of voluntary HIV-1 counseling and testing in individuals and couples in Kenya, Tanzania, and Trinidad: A randomized trial," *Lancet,* Vol. 356(9224), p.103−112.

Cochrane, John H. (2001) *Asset Pricing.* -- Princeton University Press.

Coller, Maribeth, & Melonie B. Williams (1999). "Eliciting individual discount rates," *Experimental Economics*, Vol. 2(2), p.107−127, December.

Cox, James C. & Vjollca Sadiraj (2006). "Small- and large-stakes risk aversion: Implication of concavity calibration for decision theory," *Games and Economic Behavior*, Vol. 56(1), p.45−60.

Cubitt, Robin P., Chris Starmer & Robert Sugden (1998). "On the validity of the random lottery incentive system," *Experimental Economics*, Vol. 1(2), p.115−131, September.

De Weerdt, Joachim & Stefan Dercon (2006). "Risk-sharing networks and insurance against illness," *Journal of Development Economics*, Vol. 81(2), p.337–356, December.

Dercon, Stefan & Pramila Krishnan (2000). "In sickness and in health: risk sharing within households in rural Ethiopia," *Journal of Political Economy*, University of Chicago Press, Vol. 108(4), p.688−727, August.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, & Gert G. Wagner (2005). "Individual risk attitudes: New evidence from a large, representative, experimentally-validated survey," *IZA Discussion Paper 1730*, September.

Fafchamps, Marcel (1999). "Rural poverty, risk and development," Report submitted to the Food and Agricultural Organization, Center for the Study of African Economies, Oxford University, October.

Ferreira, P.C. & Pessoa S. (2003). "The Long-Run Economic Impact of AIDS," *Working Paper,* Graduate school of Economics (EPGE), Rio de Janeiro, February.

Frederick, Shane, Loewenstein, George and O'Donoghue, Ted (2002). "Time discounting and time preference: A critical review." *Journal of Economic Literature*, American Economic Association, Vol. XL, p.351−401, June.

Freire, Sandra (2004). "Impact of HIV/AIDS on saving behaviour in South Africa," African Development and Poverty Reduction: The Macro-micro linkage, Forum paper, Somerset West, October 13−15.

Gan, Li, Guan Gong, Michael D. Hurd, & Daniel L. McFadden (2004). "Subjective mortality risk and bequests," *NBER Working Paper No. W10789*, September. Available at SSRN: http://ssrn.com/abstract=595188.

Gan, Li, Colin Xu & Yang Yao (2006). "Health shocks, village elections, and long-term income: Evidence from rural China," *NBER Working Paper No. W12686*, November.

Gertler, Paul J. & Jonathan Gruber (1997). "Insuring consumption against illness," *NBER Working Paper No. W6035,* National Bureau of Economic Research, Inc.

Gisselquist, David, Richard Rothenberg, John Potterat & Ernest Drucker (2002). "HIV infections in sub-Saharan Africa not explained by sexual or vertical transmission," *International Journal of STD & AIDS*, Vol. 13: p.657−666.

Harris, M. & Van Aardt, C.J. (2007). "Fusing HIV/Aids risk segmentation and demographic modelling: a novel way of looking at the business impact of HIV/Aids in South Africa." Paper given at SABCOHA breakfast on January 30, Johannesburg.

Harrison, Glenn W., Morten I Lau & Melonie B. Williams (2002). "Estimating individual discount rates in Denmark: A field experiment," *American Economic Review*, Vol. 92(5), p.1606−1617, December.

Harrison, Glenn W., Ronald M. Harstad & E. Elisabet Rutström (2004). "Experimental Methods and Elicitation of Values," *Experimental Economics*, Vol. 7(2), p.123-140, June.

Harrison, Glenn W., Morten I. Lau, E. Elisabet Rutström & Melonie B. Sullivan (2005a). "Eliciting risk and time preferences using field experiments: Some methodological issues," in J. Carpenter, G. W. Harrison and J. A. List (eds.), *Field Experiments in Economics* (Greenwich, CT: JAI Press, Research in Experimental Economics, Vol. 10).

Harrison, Glenn W., Steven J. Humprey & Arjen Verschoor (2005b). "Choice under uncertainty: Evidence from Ethiopia, India and Uganda," *Working Paper 05-29*, Department of Economics, College of Business Administration, University of Central Florida.

Harrison, Glenn W., Morten I. Lau, E. Elisabet Rutström & Marcela Tarazona-Gómez, (2005c). "Preferences over social risk," *Working paper 05-06*, Department of Economics, College of Business Administration, University of Central Florida.

Harrison, Glenn W., Eric Johnson, Melayne M. McInnes & E. Elisabet Rutström (2005d). "Risk aversion and incentive effects: Comment," *American Economic Review*, Vol. 95(3), p.897−401, June.

Harrison, Glenn W., Morten I. Lau, & E. Elisabet Rutström (2007). "Estimating risk attitudes in Denmark: A field experiment," *Scandinavian Journal of Economics*, forthcoming.

Holt, Charles A., and Laury, Susan K. (2002). "Risk aversion and incentive effects," *American Economic Review*, Vol. 92(5), p.1644−1655, December.

Hurd, Michael D. (1989). "Mortality risk and bequests," *Econometrica*, Vol. 57(4), p.779−813, July.

Kochar, A. (1995). "Explaining household vulnerability to idiosyncratic income shocks (in household savings and human investment behavior in development)," *American*

Economic Review, Vol. 85(2), Papers and Proceedings of the Hundredth and Seventh Annual Meeting of the American Economic Association Washington, DC, January 6−8, 1995 (May, 1995), p.159−164.

Kochar, A. (2004). "Ill-health, savings and portfolio choices in developing economies," *Journal of Development Economics*, Vol. 73(1), p.257−285, February.

Lawrance, Emily C. (1991). "Poverty and the rate of time preference: Evidence from panel data," *Journal of Political Economy*, University of Chicago Press, Vol. 99(1), p.54−77, February.

LeMay, Philippe (2007). "Insurance for the poor: The case of informal insurance groups in Benin," *CERT Discussion paper 2007/07*, September.

Loayza, Norman, Klaus Schmidt-Hebbel & Luis Servén (2000). "Saving in developing countries: An overview." *World Bank Economic Review,* Vol. 14 (3), p.393−414.

Lowenstein, George (2005). "Hot-cold empathy gaps and medical decision making," *Health Psychology*, Vol. 24(4 suppl.), p.S49-S56.

Maital, S. & S. Maital (1977). "Time preference, delay and gratification and the intergenerational transmission of economic inequality: A behavioral theory in income distribution," in: Ashenfeltar, O., Oates, W. (Eds.), Essays in Labor Market Analysis in Memory of Yochanan Peter Comay, Wiley Publishing, New York, p. 179–200.

Marzo, Frederica (2004). "The impact of HIV/AIDS on chronic and transient poverty." *Working paper*, CREST, March.

Moore, Jim (2004). "The puzzling origins of AIDS." *American Scientist*, Nov-Dec 2004, Vol. 92(6), p.540−547.

Morgan, Dilys, Mahe, Cedric, Mayanja, Billy, Okongo, J. Martin, Lubega, Rosemary & Whitworth, James A.G. (2002). "HIV-1 infection in rural Africa: Is there a difference in median time to AIDS and survival compared with that in industrialized countries?" *AIDS* 16, p.597-603, March.

Ntozi, James P.M. (2002). "Impact of HIV/AIDS on fertility in Sub-Saharan Africa," *African Population Studies*, Vol. 17(1), p.103-124.

O' Donoghue, Ted & Matthew Rabin (1999). "Doing it now or later," *American Economic Review*, Vol. 89(1), p. 103–124.

O' Donoghue, Ted & Matthew Rabin (2000), "Risky behavior among youths: Some issues from behavioral economics," Economics Department, University of California, Berkeley, *Working Paper E00-285*.

O' Donoghue, Ted & Matthew Rabin (2001). "Self awareness and self control," forthcoming in *Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice*." George Loewenstein, Daniel Read, and Roy Baumeister, eds. NY: Russell Sage, in press.

Olson, Mancur & Martin J. Bailey (1981). "Positive time preference," *Journal of Political Economy*, University of Chicago Press," Vol. 89(1), p.1−25, February.

Over, Mead (1992). "Macroeconomic impact of AIDS in sub-Saharan Africa," Washington D.C.: World Bank (Population and Human Resources Department), June.

Pettifor, Audrey E., Helen V. Rees, Annie Steffenson, Lindiwe Hlongwa-Madikizela, Catherine MacPhail, Kerry Vermaak & Immo Kleinschmidt (2004). "HIV and sexual behaviour among young South African: A national survey of 15-24 year olds," Reproductive Health Research Unit, University of the Witwatersrand, Johannesburg.

Picone, Gabriel, Frank Sloan & Donald Taylor (2004). "Effects of risk and time preference and expected longevity on demand for medical tests," *Journal of Risk and Uncertainty* Vol. 28(I), p.39–53.

Pradhan, Basanta K., Ramamani Sundar, M.R. Saluja, Vijay Prakash Ojha, Shalabh Kumar Singh, Sampurna Singh, Abhilasha Sharma, & S.K. Mondal (2006). "Socio-Economic impact of HIV/AIDS in India," NACO/NCAER/UNDP.

Rabin, Matthew (2000). "Risk aversion and expected utility theory: A calibration theorem," *Econometrica*, Vol. 68(5), p.1281−1292, September.

Rae, John (1834) *The sociological theory of capital: being a complete reprint of the new principles of political economy*. New York: Macmillan.

Read, Daniel, N.L. Read (2004). "Time discounting over the lifespan," *Organizational behavior and human decision processes*, Vol. 94(1), p.22−32, May.

Rogers, Alan R. (1994). "Evolution of time preference by natural selection," *American Economic Review*, Vol. 84(3), p.460−481, June.

Rothschild, Michael & Joseph E. Stiglitz (1971). "Increasing Risk II: its economic consequences," *Journal of Economic Theory*, Vol. 3(1), p.66−84, March.

SA Census 2001, Statistics South Africa. (Pretoria: Statistics South Africa; 2003).

Saha, Atanu (1993). "Expo-power utility: A flexible form for absolute and relative risk aversion," *American Journal of Agricultural Economics*, Vol. 75(4), p.905−913, November.

Sandmo, Agnar (1970). "The effect of uncertainty on saving decisions," *Review of Economic Studies*, Vol. 37(3), p.353–360, July.

Siegel, Sidney. & N. John Castellan Jr. (1988). Nonparametric statistics for the behavioral sciences. McGraw-Hill, international edition 1988.

Sozou Peter P. & Robert M. Seymour (2003). "Augmented discounting: Interaction between aging and time preference behaviour," *Proceedings of the Royal Society of London B*, Vol. 270(1519), p.1047−1053, May.

Starmer, Chris & Robert Sugden (1991). "Does the random-lottery incentive system elicit true preferences? An experimental investigation," *American Economic Review*, Vol. 81(4), p.971−978, September.

Starmer, Chris (2000). "Developments in non-expected utility theory: The hunt for a descriptive theory of choice under risk," *Journal of Economic Literature*, Vol. 38(2), p.332-382, June.

Steinberg, Malcolm, Saul Johnson, Gill Schierhout, & David Ndegwa (2002). "Hitting home: how households cope with the impact of the HIV/AIDS epidemic. A survey of households affected by HIV/AIDS in South Africa," The Henry J. Kaiser Family Foundation, Washington.

Tanner, Mariah, Jayson Lusk & Wallace Tyner (2005). "A multidimensional investigation of economic behavior in four countries," *Working paper*, August. Available at: http://www.cirano.qc.ca/ee/ESA2005_Tucson/papers/Tanner.pdf

Thaler, Richard H. & Eric J. Johnson (1990). "Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice," *Management Science* 36, p.643−660.

Thirumurthy, Harsha, Johsua Graff Zivin & Markus Goldstein (2005). "The economic impact of AIDS treatment on labor supply in western Kenya," *NBER Working Paper No.11871:47*, December.

Trostel, Philip. A. & Grant A. Taylor (2001). "A theory of time preference," *Economic Inquiry*, Vol 39(3), p.379−395, July.

UNAIDS (2004). *Report on the global AIDS epidemic – 4th Global Report.* WHO Library Cataloguing-in-Publication Data, Geneva.

UNAIDS (2006). *Report on the global AIDS epidemic- A UNAIDS 10th anniversary special edition.* WHO Library Cataloguing-in-Publication Data, Geneva.

UNAIDS & WHO (2006). *Epidemic update*. UNAIDS and World Health Organization, December, Geneva.

U.S. Census Bureau (2006). International Data Base, version August 24, 2006.

World Bank (1993). *World Development Report 1993: Investing in Health*, Oxford University Press.

World Bank (1999). "Confronting AIDS: Public priorities in a global epidemic," Revised edition, Washington, D.C.: Oxford University Press.

World Health Organization (2003). *Scaling up antiretroviral therapy in resource-limited settings: Treatment guidelines for a public health approach (2003 revision)*. Geneva, World Health Organization, December.

World Health Organization (2006). *Antiretroviral therapy for HIV infection in adults and adolescents in resource-limited settings: towards universal access*. Volume 2006. Geneva.

World Health Organization (2006). World Health Statistics 2006.

World Health Organization (2007). Statistical Information System (WHOSIS). Available at: http://www3.who.int/whosis/life/life_tables/life_tables_process.cfm?country=zaf&language=en.

Yaari, Menahem E. (1965). "Uncertain lifetime, life insurance, and the theory of the consumer," *Review of Economic Studies*, Vol. 32(2), p.137–150, April.

Young, Alwyn (2005). "The gift of the dying: The tragedy of AIDS and the welfare of future African generations," *Quarterly Journal of Economics*, Vol. 120(2), p.423–466, May.

Zhang, Jie, Junsen Zhang & Ronald Lee (2003). "Rising longevity, education, savings, and growth," *Journal of Development Economics*, Vol.70(1), p.83−101, February.

URL:

http://www.edinformatics.com/biotechnology/hiv.htm

http://www.health24.com/medical/Condition_centres/777-792-814-1756,22216.asp

Appendix

Appendix A

Experimental Data

A.1 Introduction

The empirical results in this dissertation are based on an experimental study that was exclusively designed to study the research questions addressed in the introduction. This appendix describes the data and the series of experiments, which were conducted among students in 2005 and 2006 in South Africa.

Research location

To obtain a better understanding of how individuals' intertemporal choices like saving decisions change when individuals are exposed to mortality risk and HIV contraction risk, it was necessary to conduct this research in a country with a high level of HIV prevalence. South Africa was for several reasons suitable for this research: First, it has been facing high HIV prevalence rates for many years. In a well-established epidemic, individuals are more likely to consider the risk of contracting the virus, which enabled us to evaluate individuals' economic response accordingly. Second, English is the second language for most South Africans. This reduces misinterpretations of the questionnaires. Furthermore, the research could be carried out without the help of translators and interpreters. Third, South Africa has a relatively well-performing financial market. This was a prerequisite for the incentive payment

structure of the experiments (explained in Section A.2). Since financial instruments are available for a large part of the population this improved the general understanding of the questions and experimental tasks as well.

The actual research took place at both Pretoria University (PU) and Northwest University (NWU), situated in respectively the province Gauteng and North West Province of South Africa. In the latter, the research was conducted among students from both Mafikeng campus and Potchefstroom campus, two different campuses of NWU. The first series of experiments (in November 2005) were conducted at NWU only. The second round (in October 2006) took place at both universities.

Ethical approval

The ethical committee of NWU gave ethical approval for this research. Every participant has signed an informed consent form in which he officially agreed to participate in the research. The original set-up of this research included a HIV test after the session, however, because of ethical reasons; the committee did not give approval for doing this. The results on HIV status are therefore based on self-reported status only. As a result, possible differences in the parameters of this study between HIV positive subjects that are aware of their positive status and those who are not could not be evaluated. Neither could it be studied to what group HIV positive subjects belonged to based on perceived HIV contraction risk before their status is revealed.

Target group

Students were the target group, which is for practical reasons often the case in experimental research. Although the experimental methods had extensively been tested among both students and field subjects, they have not often been applied at the African continent. To be cautious, the method is therefore applied to well-educated individuals, i.e. students. Conclusions based on the empirical results in this thesis can therefore not be straight away applied to the South African population in general and should thus be interpreted with care.

The initial intention was to conduct experiments at Mafikeng campus only, since this campus consists of mainly black South African students. Pettifor et al. (2004) showed that among this ethnical group, HIV prevalence rates are significantly larger, so that a wider spread sample over the categories of perceived HIV contamination risk could be expected. Potchefstroom

campus functions as the control group, where 24 black and 32 white South Africans participated. The results show no significant differences between black South African students at Potchefstroom campus and Mafikeng campus for the main variables of interest i.e. risk aversion (RA), discount rate (D), life expectancy (LEX), and saving behavior.[1]

The second round of the experiments was conducted among HIV positive subjects only, which were recruited from the HIV supports groups at both PU and NWU. Although I am aware of the fact that this way of recruiting might lead to a selection bias, I choose to follow this procedure in order to obtain a substantial group of HIV positive subjects in the sample. The major variables do not significantly differ between the HIV positive subjects in the first round and in the second round at Mafikeng campus.[2]

A.2 Experimental set-up

Experimental team

The experimental team consisted in alphabetical order of Marten van Garderen, Judith Lammers, Morten Igel Lau, Martine Smit, and Harrie Verbon. Both Judith Lammers and Marta Serra Garcia were responsible for the data processing.

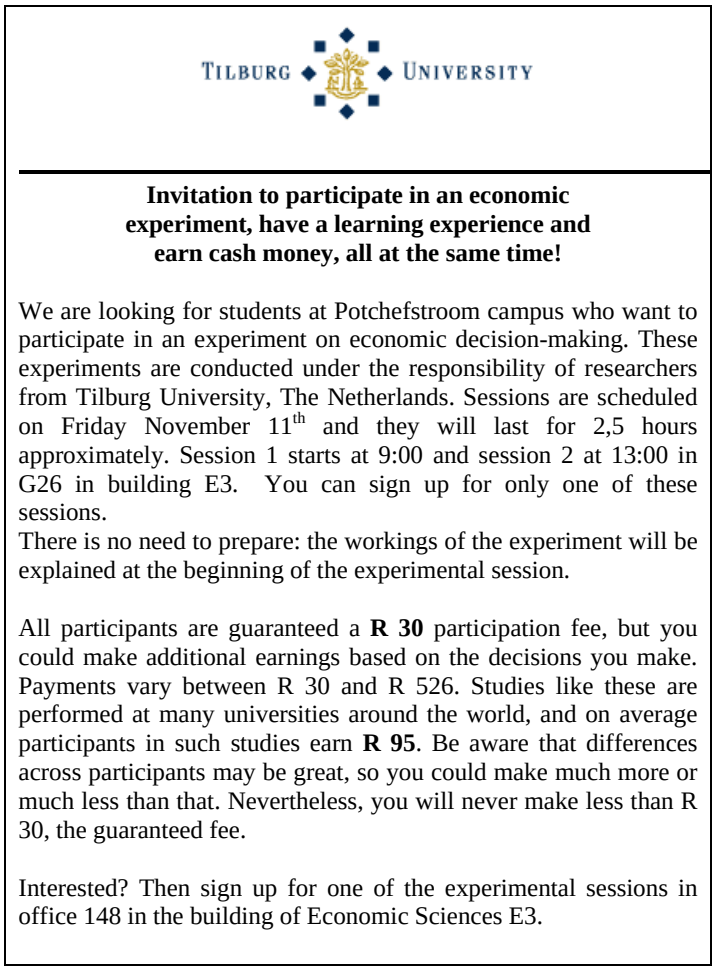
Recruitment of students

In the first round of the experiments, students were recruited using promotional flyers and posters at both campuses. Figure A.1 contains an example of these promotional flyers, which invited students to participate in an experiment on economic decision-making. To avoid a selection bias, the students were not provided with other information on the experiments, neither were they informed that this research was linked to HIV research. Subjects were paid on average a comparable hourly student wage, to reduce a possible selection bias towards income.

[1] P-value RA=0.45, p-value D=0.64, and p-value LEX=0.26. To measure saving behavior, subjects were asked whether they saved (p-value S=0.98), and whether they had a savings account (p-value SACC=0.94). Interestingly, students at Potchefstroom who did save, saved a significantly higher amount (p-value SAM=0.05). This result is however not income driven, as the two groups do not significantly differ in this respect (p-value own income=0.79, p-value income group parents=0.47. They did also not significantly live more often in informal dwellings (p-value=0.95). All based on the nonparametric Mann-Whitney test.

[2] P-value RA=0.83, p-value D=0.30, p-value LEX=0.77, p-value S=0.64, p-value SACC=0.32, p-value SAM=0.59 based on the nonparametric Mann-Whitney test.

Figure A.1: Promotional flyer (Potchefstroom campus).



TILBURG UNIVERSITY

Invitation to participate in an economic experiment, have a learning experience and earn cash money, all at the same time!

We are looking for students at Potchefstroom campus who want to participate in an experiment on economic decision-making. These experiments are conducted under the responsibility of researchers from Tilburg University, The Netherlands. Sessions are scheduled on Friday November 11th and they will last for 2,5 hours approximately. Session 1 starts at 9:00 and session 2 at 13:00 in G26 in building E3. You can sign up for only one of these sessions.
There is no need to prepare: the workings of the experiment will be explained at the beginning of the experimental session.

All participants are guaranteed a **R 30** participation fee, but you could make additional earnings based on the decisions you make. Payments vary between R 30 and R 526. Studies like these are performed at many universities around the world, and on average participants in such studies earn **R 95**. Be aware that differences across participants may be great, so you could make much more or much less than that. Nevertheless, you will never make less than R 30, the guaranteed fee.

Interested? Then sign up for one of the experimental sessions in office 148 in the building of Economic Sciences E3.

Session schedule

In the first round, students were signed up in ten different sessions. Each session was conducted in lecture rooms with the number of students ranging from 15 to 28. The first seven sessions have been conducted at Mafikeng campus and the other three at Potchefstroom campus. The second round of experiments took place at locations where the HIV support groups regularly meet. Only one of the HIV support group attendances decided not to participate. Table A.1 provides more details on the sessions.

Table A.1: Session information.

Session	Date	Time	Experi-menter	Campus	Number	Signed-up	Show-up rate	FED	nFED
1	Wed, Nov 02-05	09:00	Judith	Mafikeng	20	25	80%	20	-
2	Thu, Nov 03-05	13:00	Morten	Mafikeng	22	27	81%	22	-
3	Fri, Nov 04-05	09:00	Judith	Mafikeng	20	26	77%	-	20
4	Fri, Nov 04-05	13:00	Morten	Mafikeng	15	27	56%	-	15
5	Mo, Nov 07-05	13:00	Judith	Mafikeng	20	33	61%	20	-
6	Tue, Nov 08-05	09:00	Judith	Mafikeng	16	33	48%	16	-
7	Tue, Nov 08-05	13:00	Judith	Mafikeng	28	45	62%	-	28
8	Fri, Nov 11-05	09:00	Judith	Potchefstroom	17	25	68%	-	17
9	Fri, Nov 11-05	13:00	Judith	Potchefstroom	20	29	69%	20	-
10	Mo, Nov 14-05	11:00	Judith	Potchefstroom	19	23	83%	19	-
11	Tue, Oct 24-06	17:00	Judith	Mafikeng	6	-	-	6	-
12	Wed, Oct 25-06	12:00	Judith	Pretoria	10	-	-	10	-
			Total	**10**	**197**	**293**	**68%**	**117**	**80**
			Mafikeng	*8*	*141*	*216*	*66%*	*84*	*63*
			Potchefstroom	*3*	*56*	*77*	*73%*	*39*	*17*
			Pretoria	*1*	*10*	-	-	*10*	

Experimental procedure

The experimental sessions were organized as follows: Before each session started, subjects had to hand in a signed informed consent form corresponding to the rules and regulation of NWU. Next, subjects picked an ID number randomly from an envelope, which they had to write on every part of the experiment. This number was used to keep track of who answered which questions, so that anonymity could be guaranteed. Subjects had to take place in rows with one seat in between to give them sufficient privacy in answering the questions.

The sessions began by welcoming the subjects and reminding them that they were to be paid 30 Rand[3] for their participation as long as they stayed for the entire session. Under this condition, subjects were given the opportunity to leave, but nobody did. The instructions for the experiment were provided on paper, and subjects read them, while the experimenter read them aloud. The experimenter used a script (included in Appendix C) including the instructions for the complete session, which was identical for all 12 sessions. The experimenter emphasized that there were no right or wrong answers.

For the randomization procedures in the experiment, a six-sided die, a ten-sided die, and a bingo cage containing 100 balls were used. The experimenter asked a volunteer to inspect the bingo cage and put all 100 balls, numbered from 1 to 100, in the bingo cage.

[3] At the time of the experiment the exchange was: Rand (R), R 1 ≈ 0.14 USD

The total experiment was conducted in five parts of which three different questionnaires and two experimental tasks. Appendix D and E contain respectively the experimental tasks and the questionnaires. The first part of the experiment concerned a questionnaire regarding socio-demographic characteristics such as age, gender, race etc. Part II of the experiment consists of a risk aversion task including an example to practice. Part III constituted of six discount rate tasks. Section A.3 of this appendix will explain Part II and III in more detail. Part IV consisted of a questionnaire concerning questions related to the subject's saving and borrowing behavior, and subjects' expectations about their future economic conditions, and of the country as a whole. Part V consists of questions related to health, which was scheduled at the end of the experiment so that subjects would not link the experiments to HIV research while answering the first four parts. This last questionnaire aimed at eliciting subjects' perceptions of life expectancy and HIV contraction risk, sexual behavior, and HIV status. Furthermore, the respondents were asked whether they had medical insurance.

Motivating Participants

In addition to a show-up fee of 30 Rand, performance-based real incentives were used to motivate participants based on the random lottery incentive system, the nowadays almost exclusively used incentive system for individual choice experiments (Holt & Laury, 2002). The main advantage of this system is that it avoids income effects such as Thaler & Johnson's (1990) house money effect[4], while it has been shown empirically that it is indeed incentive compatible, that is, agents do not interpret choice tasks rewarded with the random lottery incentive system as one grand overall lottery (Cubitt et al. 1998, Starmer & Sugden 1991). Since the task reported here was part of a larger experiment that all involved outright choices between two options, the probability that one of the chosen options would be played out for real was low. To be specific, in Part II and III each subject had a 10% chance of receiving some additional money in addition to the participation fee. On average participants could earn 65 Rand in the valuation task. While the participation fee and the additional money earned in Part II were paid cash, the additional payment in Part III, was paid by handing over a postdated check issued by Tilburg University, which could be cashed at any Standard Bank in South Africa any time after the specified date.

[4] The premise that people are more willing to take risks with money they obtained easily or unexpectedly.

A.3 Experimental tasks

The experimental tasks are based on the risk aversion experiments of Binswanger (1980), Holt & Laury (2002) and Harrison et al. (2005a) and the discount rate experiments of Coller & Williams (1999) and Harrison et al. (2002). The amounts used in the different experimental tasks are based on Harrison et al. (2002, 2005a), corrected for the South African living standard.

Part II

In Part II, subjects were presented with a menu of choices that permits measurement of the degree of risk aversion using a so-called *multiple-price list* (MPL) design based on Holt & Laury (2002) and Harrison et al. (2005a). Each subject was asked to make a choice between two lotteries, which are called option A and option B. See column 2 and 3 in the table below.

Table A.2: The ten paired lottery choice decisions.

Decision	Option A	Option B	Expected Payoff		Expected payoff Difference
1	R 50.00 if ball is 1-10 R 40.00 if ball is 11-100	R 96.25 if ball is 1-10 R 2.50 if ball is 11-100	41	11.88	29.13
2	R 50.00 if ball is 1-20 R 40.00 if ball is 21-100	R 96.25 if ball is 1-20 R 2.50 if ball is 21-100	42	21.25	20.75
3	R 50.00 if ball is 1-30 R 40.00 if ball is 31-100	R 96.25 if ball is 1-30 R 2.50 if ball is 31-100	43	30.63	12.38
4	R 50.00 if ball is 1-40 R 40.00 if ball is 41-100	R 96.25 if ball is 1-40 R 2.50 if ball is 41-100	44	40.00	4.00
5	R 50.00 if ball is 1-50 R 40.00 if ball is 51-100	R 96.25 if ball is 1-50 R 2.50 if ball is 51-100	45	49.38	-4.38
6	R 50.00 if ball is 1-60 R 40.00 if ball is 61-100	R 96.25 if ball is 1-60 R 2.50 if ball is 61-100	46	58.75	-12.75
7	R 50.00 if ball is 1-70 R 40.00 if ball is 71-100	R 96.25 if ball is 1-70 R 2.50 if ball is 71-100	47	68.13	-21.13
8	R 50.00 if ball is 1-80 R 40.00 if ball is 81-100	R 96.25 if ball is 1-80 R 2.50 if ball is 81-100	48	77.50	-29.50
9	R 50.00 if ball is 1-90 R 40.00 if ball is 91-100	R 96.25 if ball is 1-90 R 2.50 if ball is 91-100	49	86.88	-37.88
10	R 50.00 if ball is 1-100	R 96.25 if ball is 1-100	50	96.25	-46.25

The first decision row shows that option A entails a lottery, which offers a 10% chance of receiving 50 Rand and a 90% chance of receiving 40 Rand. The expected value of this option is 41 Rand and is shown in the fourth column of the table. The last two columns of Table

A.2, however, was not presented to the subjects. Similarly, option B in the first row has chances of payoffs of 96.25 Rand and 2.50 Rand, which corresponds to an expected value of 11.88 Rand. The expected value of the lottery of option A is 29.13 Rand higher than option B. Thus, only an extreme risk-seeker would choose option B. Appendix D contains the actual tables of the experiment.

All other decisions in the table are similar, except moving down the table, the chances of receiving the higher payoff for each option increase. When the probability of the high-payoff outcome increases enough, the subject should cross over to option B. A risk-neutral subject would choose four times option A before switching to option B. In the bottom row, even the most risk-averse subject should switch to option B, since this option yields a sure payoff of 96.25 Rand.

Table A.3: Selection of decision rows by bingo ball draw (Part II).

Bingo ball number is between	**Decision row selected**
1 and 10	1
11 and 20	2
21 and 30	3
31 and 40	4
41 and 50	5
51 and 60	6
61 and 70	7
71 and 80	8
81 and 90	9
91 and 100	10

After all subjects completed the task, the experimenter generated some random draws to determine the possible additional payment of this task. First, for all subjects together, he drew a ball to select one decision row from the table using the bingo cage. Table A.3, showing which ball selects the corresponding decision row, was used for clarification of the selection process.

A second draw determined whether subjects were to receive the high or the low payment. At this point all subjects knew whether they were playing lottery A or lottery B and what amount they would receive if they were selected to receive the additional payment. Finally, every subject rolled a ten-sided die in a lid. Only those subjects who drew a "0" received the

additional payment, which value thus depended both on the random draws and on subjects' choice made in the selected row. All draws were registered and payments were made in private at the end of the session.

To illustrate the specific procedures, subjects could practice with this type of task, the random draws, and the registration of these draws by doing an example (see Table D.1 in Appendix D). Also in this case, the subjects were paid according to their choices. In the example, however, the amounts were indicated in the number of sweets and thus subjects were paid in number of sweets when selected for additional payment.

Table A.4: Discount rate task (FED-treatment): framing of the options (Problem 6).

Decision	Option A To be paid in 1 month	Option B To be paid in 24 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 182.60	3%	(A) B
2	R 172	R 193.76	6%	(A) B
3	R 172	R 205.51	9%	(A) B
4	R 172	R 217.88	12%	(A) B
5	R 172	R 230.90	15%	(A) B
6	R 172	R 244.60	18%	(A) B
7	R 172	R 259.00	21%	(A) B
8	R 172	R 274.14	24%	(A) B
9	R 172	R 290.05	27%	A (B)
10	R 172	R 306.76	30%	A (B)
11	R 172	R 324.30	33%	A (B)
12	R 172	R 342.72	36%	A (B)
13	R 172	R 362.05	39%	A (B)
14	R 172	R 382.32	42%	A (B)
15	R 172	R 403.58	45%	A (B)
16	R 172	R 425.87	48%	A (B)
17	R 172	R 449.22	51%	A (B)
18	R 172	R 473.69	54%	A (B)
19	R 172	R 499.32	57%	A (B)
20	R 172	R 526.15	60%	A (B)

Part III

In Part III, subjects were presented with a different type of MPL to measure individual time preferences. Participants were asked to make 20 outright choices in six different tables

between two options, called option A and option B, by simply encircling the preferred option on a sheet of paper. The options were presented in a table format similar to Table A.4 reproduced above, as to make the task as easy and transparent as possible. The tables are based on the MPLs used in Harrison et al. (2002), which were adjusted to the South African living standard. Both options yielded monetary prizes at specified dates. More specifically, option A yielded 172 Rand in X months, while option B yielded an amount of 172+Y Rand in Z months. The amount 172+Y Rand that option B yielded increased after each choice, starting at 172+Y=172.43 Rand (see Appendix D, Problem 1). Within each table, the amount (Y) increased down the table over 20 different decision rows reflecting annual market interest rates from 3% to 60%, like in Table A.4 where Z is equal to 24 months. Thus, option B became more and more attractive after each choice. Decision row 10 provides the subject with a choice between option A, which pays 172 Rand today, and option B, which pays 306.76 Rand over 24 months, which reflects an if annual interest rate of 30%. In addition, participants received information about the annual interest rate that reflected the different prizes offered by option B, similar to Coller & Williams (1999) and Harrison et al. (2002). In this way, subjects were provided with the field opportunities, which enabled them to compare these with the laboratory experiment. Subjects were provided with six different problems, were the number of months, Z, increased from 2 to 24, covering six different time horizons (Z=2, 4, 6, 12, 18, and 24).

For any given subject, the point at which they switch from choosing the present income option A to taking the future income option B, provides a boundary on the discount rate. If an individual choose option A, for all X up to 27%, and then switches to the future income option B, it can be deduced that his discount rate over Z months lies between 27% and 30%. Although, indeed some precision is lost by this interval procedure, the simple presentation of the MPL is likely to minimize confusion compared to more precise, but more complicated or computerized procedures.

In this part, each subject had again, a 10% chance to receive an additional sum of money. How much they received depended partly on chance and partly on the choice, the subjects made in the six different problems. After all six problems of the discount rate tasks were filled out; the experimenter asked one of the subjects to throw a six-sided die to select the problem to be paid out. Next, he performed a random draw with the bingo cage, which selected the

decision row. Finally, subjects again threw a ten-sided die. Payments were made, if the subject threw a "0".

Before the subjects began to work on the six tables the experimenter carefully explained how subjects would be paid in this part of the experiment. Subjects that were selected to receive the additional payment in this part of the experiment received a postdated check, which could only be cashed after the specified date.

Treatment

There is empirical evidence that agents are more impatient about immediate delays than they are about future delays of the same length (Coller & Williams 1999). This effect is stronger in "hot" behaviors like sexual behavior (see Chapter 3). Therefore, the timing of the prizes of both options varied between the treatments. More specifically, in one treatment, called FED (Front-End Delay), subjects had to choose between two future payment options, i.e. option A always yielding a prize that would be paid in one month, and option B yielding a prize that would be paid in Z months. In the other treatment, called nFED (no Front-End Delay), option A always yielded an *immediate* prize instead while option B yielded a prize that would be paid in Z – 1 months. To be specific, in four out of twelve sessions, subjects were asked to choose between a present and a future payment option instead of two future payment options (see Table A.1). The time horizon between the treatments over the six different problems was kept the same.

To avoid the potential problem of subjects facing transaction costs with the future income option, which they would not have with the present income option, the present income option was paid with the same postdated checks. Moreover, if despite this attempt to ensure full credibility in paying out the subjects, the subjective probability of receiving the future payment is less than 100%, the fact that both payment options are in the future (although the first in the very near future), should minimize any differences in perceived risk between the two payment options. So, by offering subjects in both payment options a check avoided the problem of additional transaction costs and minimized the credibility problems.

A.4 Questionnaires

Since there are variations in responses in the two experimental tasks across subjects, it is of interest to analyze whether these response variations can be captured by observable characteristics. A wide range of characteristics of each subject was collected in three different questionnaires, all included in Appendix E:

1. Socio-Demographic questionnaire (Part I)
2. Financial questionnaire (Part IV)
3. Health questionnaire (Part V)

The first two questionnaires, notably the financial questionnaire, are based on the study of Harrison et al. (2002). They were adjusted and supplied with questions from the South African Census 2001. Harrison et al. (2002) did not have a health questionnaire in their study, and thus the health questionnaire needed to be developed. Part of the questions, however, were based on Pettifor et al. (2004), who studied sexual behavior among the youth in South Africa. Experts in the field of HIV in South Africa, development economics, and experimental economics reviewed the questionnaires thoroughly.

Socio-demographic questionnaires

The socio-demographic questionnaire contains both questions on individual current characteristics and background characteristics like age, gender, field of study etc. Besides, questions were asked about the current household situation, like household composition, income, housing etc. Because the current household situation of students may not be a good representation of the socio-demographic background of students, in addition, questions were asked about the family situation when the students were 15 years old, including employment status and educational level of the parents.

In order to be able to control for altruistic behavior and to check their willingness to save in the discount rates tasks, subjects were asked moreover to indicate what they were planning to do with the money of they would win 650 Rand.

Financial questionnaire

The financial questionnaire contained questions on what financial instruments participants use, such as whether they save or not, the current balance on their savings account, and what

market rates of interest they face. This information was in the first place used to elicit financial behavior, so that the relation between this behavior and the perceived HIV contraction risk or HIV status could be analyzed. Second, the information was used to allow for the possibility that responses in the discount rate task are censored by the market rates. A rational subject should never choose to postpone payment in the experiment at interest rates, lower than those she can receive in the external market. Furthermore, subjects may attempt to arbitrage between the lab experiment and the field, so that the discount rates revealed in the lab experiment may not reflect their actual time preference of money.[5] Due to a lack of response on the interest that the participants face in the financial market, corrections for censored responses were not sensible. Because only few subjects did report on the interest rates they face, so that knowledge on the arbitrage possibilities was very low, reducing the occurrence of censored responses.

Risk aversion and time preferences may vary with past and expected future income as well as with the economic conditions of a country. To be able to correct for the past and future expected financial position, subjects were asked to report this for the same time horizons as in the six discount rate problems (see Appendix E, questions VI.11-17).

Health questionnaire

Economic theory shows that lifetime choices heavily depend on life expectancy and health (see Chapter 3). To obtain a better understanding in to what extent populations in countries affected by HIV are also aware of the increase in illness and mortality risk, the health questionnaire included among other health related issues the following three questions:

"How old do you think, you will become?" _____years (question V.4)

[5] Consider, for example, a subject with the discount rate of 9%. In the absence of field substitutes of the lab incentives, it is expected that this object chooses to invest in the lab instrument (choose option B) as long as the return is 9% or higher. Suppose the subject can save in the field at the interest rate of 12%. This subject would be better off investing in the field in this refusing the lab investment option even though her true discount rate is 9%. The problem is asymmetric for subjects with a discount rate high than the true rate of borrowing in the field.

"What do you think your chances are of getting HIV/AIDS?" (question V.10A)

01 No risk at all

02 Small

03 Moderate

04 High

"Have you ever been tested for HIV?" (question V.14)

01 Yes, my status was HIV positive

02 Yes, my status was HIV negative

03 No, I have never been tested

04 I prefer not to answer this question

The first question provides the individual expected lifespan of the respondents. The latter two questions enabled to classify students by perceived HIV contamination risk and HIV status. It is important that the answers to the first two questions are self-reported perceptions of both life expectancy and HIV contraction risk. Assuming that students truthfully reported on these perceptions, this is *exactly* the information that is needed for this study. Namely, these *perceptions* would influence economic behavior and not the *actual* individual life expectancy and HIV contamination risk.

Sensitivity issues/data limitations

Since this research contains highly sensitive questions, there are some limitations in the dataset. The collected data reported in this thesis, represents information provided by the subjects themselves. Answers might be biased towards socially excepted answers, especially in case the information is rather sensitive, like the questions about sexual behavior and HIV status. In order to assure anonymity as much as possible the following ten measures were applied:

1. The subjects were sitting in queues and at least one seat left in between.
2. Students were not interviewed, but they had to read and fill out the questions by themselves.

3. All students randomly took a personal ID number, so that their answers could not be linked to their names.
4. In the instructions, it was emphasized that the experiment was anonymous.
5. The questionnaires were designed in a way that, except for the ID number, the first page was blank.
6. On forehand, the experimenter made absolutely clear that he would collect the questionnaires by letting *the students* put the questionnaire in a closed box.
7. In highly sensitive questions, objects were given the option to select "I prefer not to answer this question".
8. Students were not allowed to talk, when filling out the questionnaires and experimental tasks.
9. The experimenter avoided walking through the lecture room, while students were filling out the questionnaires.
10. Participants were paid out in private.

A.5 Sample characteristics

This section provides a general description on the characteristics of the sample. Appendix B contains the tables with the main descriptive statistics both for the whole sample (Tables B1–B3) and classified by perceived HIV contamination risk (Tables B4–B6).

Socio demographic data

A total of N=213 students (114 males and 99 females) from a wide range of disciplines recruited at the Northwest University and the University of Pretoria in South Africa participated in the experiment. In the first round of the experiments, data of 197 subjects was collected and in the second round data of 16 subjects. The total sample included 82% black South Africans, 15% white, and the remaining 3% was colored. Remarkably, 96% of the HIV positive subjects were black South African. The average age was 22.6 years. HIV positive subjects were significantly older (25.1 years). Also the group of students who reported to be at risk of contracting HIV was on average older (23.4 years).

Most of the respondents were living in urban areas (62%). Among the group who perceives to be highly at risk of contracting HIV during their lifetime and the HIV positive group were more likely to live in urban areas (68%, 65% vs. 60%). They were also more likely to live in an informal dwelling (12%, 9% vs. 2%). Most of the subjects were living in a student residence

(44%). While the high-risk group has a significantly lower income, remarkably, the income of the HIV positive group is on average higher. A relatively low percentage of the high-risk group had a family of their own (4% vs. 9%).

Looking at the socioeconomic background of subjects, the high-risk group and the HIV positive group appear to come from families, where the head of the household was more likely to be informally employed (25%, 22% vs. 11%) or unemployed (13%, 17% vs. 10%). On average nonwhite students were poorer; the income distribution of nonwhite subjects is skewed to the left whereas the income distribution of white students is skewed to the right. Among those subjects that perceive to be highly at risk, almost one fourth was living in an informal dwelling at age 15. A remarkably low percentage of HIV positive subjects was studying economics (14% vs. 30%).

Financial data

The most frequently used financial instrument was a savings account (64% reported to save and among this group 77% reported to have an account). However, over 51% of the subjects having such an account, reported that they did not know the interest rate they receive on the account. Overall knowledge of market rates of interest was low. Moreover, if subjects did report an interest rate, the rate varied among the subjects for similar financial instruments. For example, the average reported interest on a savings account was 10.73% with a standard deviation of 9.76. Although both subjects who perceived to have a high chance of contracting HIV and HIV positive subjects saved a larger amount of money on a formal savings account, it were the HIV positive subjects who saved most frequently and had such an account. Interestingly, between both groups, informal savings occurs significantly less frequently compared to the other groups (44% vs. 60%).

Only 15% reported to have a credit card, 9% and 16% for respectively nonwhites and whites. To store cards were more popular, 49% of the subjects reported to have such a card. The balance owed on these cards was significantly higher among the high-risk group and the HIV positive group. Nonwhites appeared to have less arbitrage possibilities since 29% reported to have a reasonable chance of at least 75% being approved compared to the 32% of the white. Remarkably, on average HIV positive subjects did not report to have a lower probability of obtaining a loan.

Health data

Reported life expectancy lies between 25 and 120. Nonwhites estimated their life expectancy on average 4.5 years lower compared to white subjects. The expected remaining lifetime was significantly shorter for both subjects who perceived to be highly at risk of contracting the virus and for the HIV positive group. On average, they estimated their expected time until death respectively 7 and 17 years shorter. Remarkably, black South African students at Potchefstroom campus expected to live significantly longer compared to students at Mafikeng campus (48 vs. 55 years, p-value=0.09).

Although 82% of the nonwhites (91% of the white) reported having received any medical consultation in the past year, only 23% (90% of the white) reported to have medical insurance. 17% of the respondents prefer a traditional or alternative mode of treatment like the sangoma, praying etc. Although there was no statistical difference in this respect among white and nonwhite subjects, the percentage of both respondents from the high-risk group and the HIV positive group was higher (24%, 22% vs. 15%).

Sexual behavior

17% of the subjects reported to have ever been pregnant or have impregnated someone of whom 57% was female. The percentage was much higher among the high-risk group and HIV positive respondents (24%, 30% vs. 15%). Pregnancy rates indicate the minimum level of unprotected sexual intercourse in the sample. 83% of the respondents is sexually active among which 88% report to regularly use condoms, however, 79% reported also to have used a condom the last time they had sexual intercourse. Condom use among the high-risk group was lower (regular condom use: 81%, last time condom use: 68%). A worrisome percentage of HIV positive subjects did not use a condom the last time she had sexual intercourse (14%).

HIV status, testing and perception

Overall, 81% of the respondents reported HIV/AIDS as major cause of death. None of the subjects indicated that other students had no risk at all of contracting the virus during their lifetime. Whereas 52% thought that other students were highly at risk only 24% of these indicated to be highly at risk themselves. Overall, students from Mafikeng campus indicated to be highly at risk more frequently compared to black South African students from Potchefstroom campus (17% vs. 11%).

More than half of the respondents (51%) had never been tested for HIV. 33% reported to be tested HIV negative, and 11% HIV positive. Although subjects were offered the option to not reveal their test status, only 5% indicated that they did not prefer to answer that question. There was no significant difference in the testing behavior between the two campuses (p-value=0.20), neither between white and nonwhite students from Potchefstroom campus (p-value=0.54). Among those subjects who did never got tested, 56% reported to undergo a HIV test if it would have been provided.

Financial behavior and risk and time preferences

When analyzing responses in saving behavior it is important to know what the characteristics are of people that do not save or not borrow. The average discount rate corrected for mortality and risk attitude among non-savers is almost 5 percentage points higher, indicating that non-savers have a stronger preference for the presence. The non-savers are significantly less medically insured. Savers having medical insurance, however, do not significantly save a higher amount. Although, there is no significant difference in borrowing behavior, the non-savers estimated the chance of getting approved for a loan lower, this difference is, however, not significant (p-value=0.18). No significant relation was found between getting approved for a loan and individual discount rate nor between non-borrowers and the chance of getting approved for a loan. Non-borrowers did also not display different time preferences.

None of the HIV positive non-savers did save, nor did they have a line of credit, or were medically insured. They estimated the chance of getting approved for a loan significantly lower (p-value=0.03). It might be the case that these subjects are liquidity constraint. Interestingly their discount rates are significantly lower. Subjects that report to give at least part of the money away if they would win 650 Rand have significantly lower discount rates (p-value=0.00).

A.6 Reliability issues

Sample Selection

From the 213 subjects, 1 subject did not reveal his perception of HIV contamination risk, 36 did not answer consistently (C) in the risk aversion task.[6], 4 subjects did not completely filled out the discount rate task, and 14 subjects did not reveal their expected age of death. The

[6] 'not consistently' is defined as the behavior that subjects choose the small prize when both options were sure, i.e. they choose option A in row 10 of the risk aversion task.

sample in Chapter 6 consists of 176 (RA analysis) and 208 (DR analysis) subjects. The sample in Chapter 7 consists of 163 subjects. The elicited discount rates for those answering consistently and not consistently are not significantly different. This holds for the whole group as well as for the groups classified by perceived HIV contamination risk. Chapter 7 looses a further 73 subjects when correcting for risk behavior in the estimation of the discount rate: subjects having a negative risk parameter were excluded, reducing the sample size to 90 subjects. The elicited discount rate for subjects, having a negative risk parameter is, however, not significantly different from subjects having nonnegative risk parameter. This holds for the whole group as well as for the groups classified by perceived HIV contamination risk, except for the high-risk group (p-value=0.09). See Table A.5 for more details.

As mentioned in the introduction of this appendix, the main variables show no significant differences between the first and second round of the experiment between the HIV positive subjects from Mafikeng campus. Neither did the results show significant differences between black South African students from Mafikeng and Potchefstroom campuses. With respect to the sample selection criteria presented above, no significant differences were found in the discount rate among those subjects who answered the risk aversion task inconsistently (p-value=0.60). Neither if the subjects were classified by perceived HIV contraction risk.

Table A5: Sample selection by perceived HIV contamination risk.

Perceived HIV contraction risk	RA	D	D+LEX+ C	D+LEX+ C+RA≥0
No risk at all	42	52	38	23
Small	75	83	73	46
Moderate	21	26	19	8
High	18	24	17	4
HIV+	20	23	16	9
All	176	208	163	90

Self reported status, perceived HIV contraction risk, expected lifetime

Before the empiric results could be based on self-reported sensitive data like HIV contraction risk, and life expectancy, some consistency checks were performed of which some are described below.

First, the data show a highly significantly expected negative correlation between the expected survival time and perceived HIV contamination risk (see Appendix B, Table B.6).[7] The difference in the remaining lifetime between HIV positive and uninfected subjects is almost 20 year. No significant difference was found with respect to gender. Based on the self-reported remaining lifetime, Chapter 7 calculates infection probabilities per risk group (see Table 7.3. The estimated infection rate for the moderate-risk group (18%) and the average infection probability (15%) are reasonable and close to the adult HIV prevalence rate in South Africa at the time the experiments were conducted, which was 18.8%.

Second, the data show a significant expected positive correlation between risk aversion and expected remaining lifetime (corr=0.21, p-value=0.01, see also Table 7.4). A negative, though insignificant, relation was found between expected remaining lifetime and the number of medical consultations per year (also when the HIV positive subjects are excluded from the analysis). Furthermore, a positive, though insignificant, relation between perceived HIV contamination risk and the number of medical consultations per year is found.

Third, subjects that reported to be highly exposed to contracting the virus were more sexually experienced (92%), and had more often been pregnant or impregnated someone. Among the sexually active subjects those who perceived to be highly at risk of contracting the virus were less likely to use condoms, i.e. 29% did not regularly use a condom and 32% did not use a condom the last time they had sexual intercourse. Subjects that *perceived* to be highly at risk thus also seem to have more reason to perceive to *be* highly at risk.

The results of these checks show that the self-reported status, life expectancy, and perceived HIV contamination risk make sense and can be used, though with care, in the analyses in this thesis.

Multiple switching

Compared to previous studies, a remarkably large proportion of subjects switched more than once in both tasks, i.e. 67% and, 48% in respectively RA and DR tasks (problem 6), which means that after they switched from A to B they switch back (and forward) again. Although this might seem inconsistent behavior, it could be explained by the fact that subjects are

[7] p-value=0.00, and p-value=0.00.

indifferent over a certain interval: The switching-percentage decreased when the time horizon was lengthened.[8] In the analysis, however, having a fatter interval for risk aversion and time preference could still represent subjects' preferences.

To avoid this inconsistent behavior, some studies use forced switching-points, which means that subject are not allowed to switch back (and forth). This method is often used in computerized experiments. Imposing one switching-point, however, will not reveal whether subjects are indifferent over the interval between they switch or whether they did not understand the task, presented to them. Other methods allow for an additional option "indifference". Unfortunately, this study did not include a possibility of choosing indifference in the MPLs, as a result, distinguishing between indifference or not understanding the tasks was not possible.

Ability versus indifference

Compared to the RA tasks, substantial less switching occurs in the DR tasks (16.8 percentage points). Because the DR task is easier to comprehend, this would suggest that part of the switching in the RA task could be due to misunderstanding the tasks. This section analyzes whether switching is due to ability or indifference. Although no quantitative measure for the level of subjects, like the average grade is available, the campus where subjects study might give some indication. Entrance requirements at Potchefstroom campus are stricter compared to Mafikeng campus, i.e. the minimal grade needed for the Matric is lower in Mafikeng compared to Potchefstroom. Subjects from Mafikeng campus exhibited this multiple-switching behavior in the RA task significantly more compared to subjects from Potchefstroom campus. However, when comparing the switching behavior among black South African subjects the difference becomes much less significant (p-value=0.14).[9] Remarkably, the switching behavior in the DR tasks among black South African subjects does not differ between the campuses at all (p-value=0.96). Although switching behavior in the DR tasks appears to depend on the subjects' type of study, this does not hold for the RA task. Apparently, a certain type of skills is required for using the current methods. Because the RA task is more difficult than the discount rate task, it was hypothesized that switching behavior in the discount rate task is mainly due to individual preferences than due to ability.

[8] In the six different discount rate tasks the percentage of subjects who switched more than once was 61%, 55%, 53%, 48%, and 48%, for respectively problem 1, 2, 3, 4, 5, and 6.

[9] Switching behavior appears to be significantly more frequent among black than among white South Africans (RA task: p-value=0.00).

Additionally, two other measures are used to distinguish between indifference and inability: a dummy for subjects who chose option A in the last row of the RA task. These subjects clearly did not understand the task assuming that they prefer more money compared to less. The second measure, was constructed from questions 11-17 in the financial questionnaire. Some students did not understand these types of questions, which were represented in tables like the RA and the DR tasks as well. Subjects who did not answer the tables in the financial questionnaire correctly do switch more often in the RA task but not more often in the DR tasks.

Next to the options being indifferent or not being able to read the MPLs, subjects might also not be willing to put effort in understanding the tasks. Incentives were clearly given by offering a 10% chance of additional payment corresponding to the subjects' choices. But if subjects already failed to put effort in this payment concept, the multiple switching behavior might be partly explained by this effort issue. Table A.6 presents the results of two Simple Ordered Probit models that explain the number of switching-points in each task controlling for individual characteristics like race, income, campus and study.
Switching appears to be significantly positively related to risk-tolerance. Subjects that switch more often in the RA task appear to be less patient in the DR tasks.[10] However, this does not hold using the for mortality corrected discount rate. The number of switches in the DR tasks is also significantly related to risk-tolerance and impatient behavior in the DR tasks. This suggests that switching behavior is characterized by risk-tolerance and impatient behavior. In addition, two types of inability could explain switching in the RA task: the inability to read tables, and being undergraduate. Note that switching behavior is significantly higher among nonwhites. This result might be explained by the fact that the black South African students from the sample, who all went to primary school during the apartheid, obtained different kind of education, where maybe less attention was given to a certain type of skill needed to comprehend the MPLs structure. Switching behavior in the discount rate is driven by other individual characteristics than switching behavior in the RA task: Subjects that study economics switch significantly less. Furthermore, switching depends on subjects' income. When correcting for individual characteristic, switching is not significantly related to campus. In conclusion, since switching is not related to the ability variables like reading tables or year

[10] Comparisons are based on for mortality and risk attitude corrected discount rate. See Chapter 7 for the specific derivation.

of study, a large part of the switching in the DR tasks can be explained by indifference, which is also assumed in the analyses of this thesis.

Table A.6: switching behavior (Simple Ordered Probit).

	Coefficient	**Std. Err.**
No. of switches RA		
Risk aversion (RA)	-0.85***	0.21
Discount rate (DMR6)	-0.01***	0.00
Reads table	-0.74**	0.32
White	-0.97***	0.37
Studies Economics	-0.02	0.20
Undergraduate	0.68***	0.25
Survival	-0.01	0.00
Income	-0.06	0.05
Mafikeng	0.24	0.27
No. of switches DR6		
Risk aversion (RA)	-0.74***	0.21
Discount rate (DMR6)	-0.01***	0.00
Reads table	0.03	0.34
White	-0.11	0.33
Studies Economics	0.48**	0.19
Undergraduate	0.25	0.24
Survival	0.00	0.01
Income	-0.09*	0.05
Mafikeng	-0.05	0.27

Appendix B

Definition and Descriptive Statistics of Variables

B.1 Variable definition

Variable name	Definition
Experimental variables	
Midpointra	Calculated midpoint of risk aversion interval, elicited from the risk aversion task.
Midpointdr1	Calculated midpoint of discount rate interval, elicited from the discount rate task problem 1.
Midpointdr6	Calculated midpoint of discount rate interval, elicited from the discount rate task problem 6.
Experimenter	1 if Judith Lammers is experimenter, else 0
Horizon 4 months	1 if time horizon of task is 4 month (same for z=6 to 24 months), 0 else
FED	1 if subject filled out the discount rate tasks which had a front-end-delay, 0 else
Read Table	1 if subject could fill in questions on future financial situation, else 0
Socio-demographic variables	
Age	Age of the subject
Female	1 if subject is a female, else 0
Black South African	1 if subject is black SA, else 0

Colored	1 if subject is colored, else 0
White	1 if subject is white SA, else 0
Rural	1 if subject lives in rural area, else 0
Urban	1 if subject lives in urban area, else 0
Mafikeng	1 if subjects is student at Mafikeng campus, else 0
Potchefstroom	1 if subjects is student at Potchefstroom campus, else 0
Studies economics	1 if subjects studies economics, else 0
Year of Study	Year of study in categories 1 to 6

Current household characteristics

Married	1 if subject is married, else 0
Has own family	1 if subject has a family of its own, else 0
Household size	Size of the households the subject lives
Lives in informal dwelling	1 if subject lives in informal dwelling , else 0
Lives in student residence	1 if subject lives in student residence , else 0
Own income	Income of the subject in categories 1 to 7

Household characteristics at age 15

Family size	Size of the family at age 15
Family lived in informal dwelling	1 if subject lived in informal dwelling at age 15, else 0
Unemployed parents	1 if household head of subject was unemployed at age 15, else 0
Form employed parents	1 if household head of subject was formally employed at age 15, else 0
Informally employed parent	1 if household head of subject was informally employed at age 15, else 0
Skilled parents	1 if household head at age 15 has at least tertiary education, else 0
Income group parents	Income group parents:1 for low income group, 2 middle, and 3 high.
Keep/give if wins money	How much the subject would give away if he would win R650, in categories 1 (keeps all)to 4 (gives all)
Saves if wins money	What part of the money the subject would save if he would win R650, in categories 1 (spend all) to 3 (save more than half of it)

Financial related variables	
Saves	1 if subject saves, else 0
Saves informal	1 if subject uses informal saving methods, else 0
Savings account	1 if subject has a savings account, else 0
Overdraft	1 if individual has an overdraft/line of credit, else 0
Creditcard	1 if individual has a creditcard, else 0
Storecard	1 if individual has storecard, else 0
Studentloan	1 if individual has a studentloan, else 0
Microloan	1 if individual has a microloan, else 0
Investment account	1 if individual has a investment account, else 0

Poor Chance Loan	1 if perceived probability of getting a loan is 25% or below, else 0
Financially worse off now (t)	1 if subjects financial position is worse off now compared to t months ago, else 0
South Africa worse off now (t)	1 if South Africa is worse off now compared to t months ago, else 0
Higher expenses (t)	1 if future expenses will be higher in t months, else 0
Lower earnings (t)	1 if future earnings will be lower in t months, else 0
Financially worse off (t)	1 if future financial situation will be worse in t months, else 0
Unemployment up (t)	1 if unemployment in South Africa will go up in t months, else 0
Interest rate up (t)	1 if interest rate in South Africa will go up in t months, else 0
Health related variables	
Medical insurance	1 if subjects has medical insurance, else 0
Alternative medical aid	1 if subject prefers alternative medical aid, else 0
Life expectancy	Subject's self-reported expected time of death
Survival	Subject's time till death (Life expectancy –Age)
Smokes	1 if subjects is a smoker, else 0
Cigarettes	Number of cigarettes subject smokes per day
Ranks Influenza and Pneumonia nr1	1 if influenza & pneumonia is valued as the main death cause among influenza & pneumonia, HIV/AIDS and tuberculosis, else 0
Ranks HIV nr1	1 if HIV/AIDS is valued as the main death cause among influenza & pneumonia, HIV/AIDS and tuberculosis, else 0
Ranks TBC nr1	1 if TBC is valued as the main death cause among influenza & pneumonia, HIV/AIDS and tuberculosis, else 0
Perceived probability Influenzia or pneumonia	
own	Subject's perceived probability of getting influenza or pneumonia
others	Subject's perceived probability that other students get influenza or pneumonia
compared to others	Subject's perceived probability of getting influenza or pneumonia compared to other students
Perceived probability HIV/AIDS	
own	Subject's perceived probability of getting HIV/AIDS
others	Subject's perceived probability that other students get HIV/AIDS
compared to others	Subject's perceived probability of getting HIV/AIDS compared to other students
High Perceived HIV Contamination Risk	1 if Perceived HIV is high, else 0

Perceived probability TBC	
own	Subject's perceived probability of getting TBC
others	Subject's perceived probability that other students get TBC
compared to others	Subject's perceived probability of getting TBC compared to other students
Sexual behavior	
Pregnancy	1 if subject every has been pregnant or impregnated someone
Sexintercourse	1 if subject has sexual experience, else 0
Uses condoms	1 if subject regularly uses condoms, else 0
Used condom last time	1 if subject used a condom last time he had sexual intercourse, else 0
Test status	
HIV positive	1 if subject reports to be tested HIV positive, 0 else
HIV negative	1 if subject is tested HIV negative, else 0
Not tested	1 if subject has never been tested, else 0
Wants HIV test	1 if wants to be tested for HIV/AIDS, else 0
Prefers not to answer	1 if subject prefers not to reveal his test status, else 0

B.2 Descriptive statistics

Table B1: Descriptive statistics socio demographic questionnaire

Variable	Obs	Missing	Mean	Std. Dev.	Min	Max
Age	212	1	22.61	3.34	18	36
Female	213	0	0.46	0.50	0	1
Black SA	213	0	0.82	0.39	0	1
Colored	213	0	0.03	0.18	0	1
White	213	0	0.15	0.36	0	1
Rural	213	0	0.34	0.47	0	1
Urban	213	0	0.62	0.49	0	1
Mafikeng	213	0	0.69	0.46	0	1
Potchefstroom	213	0	0.26	0.44	0	1
Studies economics	212	1	0.28	0.45	0	1
Year of study	210	3	2.38	1.07	1	5
Current household characteristics						
Married	213	0	0.01	0.10	0	1
Has own family	213	0	0.08	0.27	0	1
Household size	155	58	5.82	2.81	0	15
Lives in informal dwelling	213	0	0.04	0.19	0	1
Lives in student residence	213	0	0.44	0.50	0	1
Own income	213	0	3.09	1.94	1	7
Household characteristics at age 15						
Family size	205	8	6.06	2.78	1	19
Family lived in informal dwelling	213	0	0.14	0.35	0	1
Unemployed parents	210	3	0.11	0.31	0	1
Form employed parents	210	3	0.70	0.46	0	1
Informally employed parent	210	3	0.13	0.34	0	1
Skilled parents	201	12	0.79	0.41	0	1
Income group parents	210	3	1.54	0.55	1	3
Keep/give if wins money	208	5	1.75	0.76	1	4
Saves if wins money	204	9	0.82	0.39	0	1

Table B2: Descriptive statistics financial questionnaire

Variable	N	Missing	Mean	St.d.	Min	Max
Saves	213	0	0.64	0.48	0	1
Saves informal	137	0	0.55	0.50	0	1
Savings account	182	0	0.77	0.42	0	1
interest	68	72	10.73	9.76	0.05	45
amount	128	12	2.03	1.38	1	5
Overdraft	213	0	0.10	0.30	0	1
monthly	21	0	0.43	0.51	0	1
interest	10	11	13.23	14.66	0	50
amount	8	13	1.75	1.16	1	4
Creditcard	212	1	0.15	0.35	0	1
interest	15	16	14.10	11.45	3	40
amount	23	8	2.65	1.53	1	5
Storecard	213	0	0.49	0.50	0	1
interest	56	48	12.72	12.05	0	50
amount	95	9	2.91	1.25	1	5
Studentloan	213	0	0.61	0.49	0	1
interest	82	47	15.15	16.42	0.5	90
amount	118	11	5.29	1.12	1	6
Microloan	209	209	0.01	0.12	0	1
interest	3	0	9.50	5.77	5	16
amount	3	0	3.33	2.52	1	6
Investment	208	208	0.08	0.27	0	1
interest	11	5	6.25	3.34	1	13
amount	16	0	4.25	1.65	1	6
Poor chances loan	207	207	0.51	0.50	0	1
Compared to 1 month ago						
Financially worse off now	212	1	0.23	0.42	0	1
South Africa worse off now	209	4	0.10	0.29	0	1
Compared to 1 month later						
Higher expenses	208	5	0.37	0.48	0	1
Lower earnings	208	5	0.13	0.34	0	1
Financially worse off	207	6	0.16	0.37	0	1
Unemployment in South Africa goes up	207	6	0.22	0.41	0	1
Interest rate in South Africa goes up	207	6	0.23	0.42	0	1
Compared to 2 years ago						
Financially worse off now	211	2	0.23	0.42	0	1
South Africa worse off now	212	1	0.23	0.42	0	1
Compared to 2 years later						
Higher expenses	207	6	0.40	0.49	0	1
Lower earnings	208	5	0.05	0.21	0	1
Financially worse off	209	4	0.05	0.22	0	1
Unemployment in South Africa goes up	209	4	0.42	0.49	0	1
Interest rate in South Africa goes up	206	7	0.39	0.49	0	1

Table B3: Descriptive statistics health questionnaire

Variable	N	Missing	Mean	St.d.	Min	Max
Medical Insurance	212	1	0.32	0.47	0	1
Alternative medical aid	213	0	0.17	0.38	0	1
Consultations	209	4	2.92	1.91	1	20
Life expectancy	198	15	71.61	17.09	25	120
Survival	198	15	49.10	17.72	4	99
Smokes	212	1	0.21	0.41	0	1
Cigarettes	44	0	8.49	7.74	0	40
Ranks Influenza and Pneumonia nr1	202	11	0.08	0.28	0	1
Ranks HIV nr1	209	4	0.81	0.39	0	1
Ranks TBC nr1	204	9	0.17	0.37	0	1
Perceived probability Influenza or pneumonia						
own	211	2	2.18	0.79	1	4
others	211	2	2.67	0.72	0	4
compared to others	212	1	1.64	0.58	1	3
Perceived probability HIV/AIDS						
own	212	1	2.35	1.19	1	5
others	212	1	3.42	0.67	2	4
compared to others	209	4	1.54	0.73	1	3
Perceived probability TBC						
own	211	2	2.17	0.94	1	4
others	212	1	2.75	0.80	1	4
compared to others	212	1	1.63	0.65	1	3
Pregnancy	212	1	0.17	0.38	0	1
Sexual intercourse	212	1	0.83	0.37	0	1
Uses condoms	156	57	0.88	0.32	0	1
Used condom last time	160	53	0.79	0.41	0	1
Test status						
HIV positive	211	2	0.11	0.31	0	1
HIV negative	211	2	0.33	0.47	0	1
Not tested	211	2	0.51	0.50	0	1
Wants HIV test	206	7	0.67	0.47	0	1
Prefers not to answer	211	2	0.05	0.21	0	1

Table B4: Descriptive statistics socio demographic questionnaire classified by perceived HIV contamination risk

Perceived HIV Contraction Risk	Age	Female	Black SA	White	Rural	Urban	Mafikeng	Potchefstroom	Studies economics	Year of study	Married
Not at all (52)	21.69	0.46	0.77	0.19	0.37	0.62	0.62	0.38	0.25	2.17	0.02
Small (84)	22.46	0.42	0.74	0.24	0.31	0.63	0.67	0.33	0.33	2.54	0.00
Moderate (28)	22.04	0.43	0.86	0.07	0.43	0.50	0.86	0.14	0.29	2.25	0.00
High (25)	23.40	0.52	1.00	0.00	0.32	0.68	0.92	0.08	0.24	2.40	0.04
HIV+ (23)	25.13	0.61	0.96	0.00	0.30	0.65	0.48	0.09	0.14	2.45	0.00

Perceived HIV Contraction Risk	Has own family	Household size	Lives in informal dwelling	Lives in student residence	Own Income	Family size	Family lived in Informal dwelling	Unemployed parents	Formally employed parents	Informally employed parents	Skilled parents
Not at all (52)	0.10	6.15	0.04	0.52	2.79	5.92	0.13	0.12	0.76	0.10	0.85
Small (84)	0.07	5.86	0.01	0.49	3.48	6.00	0.11	0.08	0.75	0.11	0.80
Moderate (28)	0.11	5.32	0.00	0.39	2.96	6.04	0.18	0.11	0.63	0.11	0.70
High (25)	0.04	5.95	0.12	0.36	2.16	6.77	0.24	0.13	0.58	0.25	0.70
HIV+ (23)	0.09	5.21	0.09	0.26	3.61	5.95	0.13	0.17	0.61	0.22	0.77

Table B5: Descriptive statistics financial questionnaire classified by perceived HIV contamination risk

			Saves		Savings account			Overdraft/line of credit			
Perceived HIV Contraction Risk (N)	**Income group parents**	**Saves if wins money**	**Saves**	**Saves informal**	**Savings account**	**interest**	**amount**	**Overdraft**	**monthly**	**interest**	**amount**
Not at all (52)	1.57	1.86	0.65	0.56	0.73	11.30	2.03	0.08	0.25	10.00	-
Small (84)	1.60	1.74	0.62	0.58	0.76	10.22	1.90	0.08	0.71	12.38	1.20
Moderate (28)	1.48	1.52	0.61	0.71	0.84	10.23	1.42	0.14	0.25	21.27	3.00
High (25)	1.46	1.54	0.64	0.44	0.63	11.59	2.75	0.08	-	-	-
HIV+ (23)	1.48	1.91	0.78	0.44	0.91	11.40	2.59	0.17	0.50	4.50	2.50

	Creditcard			Storecard			Studentloan		
Perceived HIV Contraction Risk (N)	**Creditcard**	**interest**	**amount**	**Storecard**	**interest**	**amount**	**Studentloan**	**interest**	**amount**
Not at all (52)	0.17	27.33	2.63	0.52	16.81	2.73	0.65	14.74	5.17
Small (84)	0.10	7.10	2.00	0.43	10.93	2.82	0.63	9.34	5.23
Moderate (28)	0.25	15.80	2.67	0.61	12.10	2.75	0.61	23.63	5.53
High (25)	0.16	10.00	3.00	0.44	14.69	3.00	0.64	26.80	5.25
HIV+ (23)	0.13	5.00	4.50	0.57	7.80	3.80	0.35	15.00	5.75

	Microloan			Investment account			Compared to 1 month			
Perceived HIV Contraction Risk	**Microloan**	**interest**	**amount**	**Investment**	**interest**	**amount**	**Poor chances loan**	**Financially worse off now**	**South Africa worse off now**	**Higher expenses**	**Lower earnings**
Not at all	0.02	7.50	6.00	0.02	1.00	1.00	0.50	0.25	0.10	0.44	0.10
Small	0.01	5.00	1.00	0.07	7.00	5.17	0.51	0.19	0.06	0.35	0.08
Moderate	0.04	16.00	3.00	0.14	6.43	3.75	0.57	0.36	0.18	0.30	0.19
High	0.00	-	-	0.12	7.50	4.33	0.52	0.20	0.12	0.38	0.20
HIV+	0.00	-	-	0.10	6.00	4.00	0.45	0.23	0.10	0.32	0.23

	Compared to 1 month			Compared to 2 years						
Perceived HIV Contraction Risk	**Financially worse off**	**Unemployment in South Africa goes up**	**Interest rate in South Africa goes up**	**Financially worse off now**	**South Africa worse off now**	**Higher expenses**	**Lower earnings**	**Financially worse off**	**Unemployment in South Africa goes up**	**Interest rate in South Africa goes up**
Not at all	0.14	0.22	0.16	0.25	0.29	0.32	0.06	0.06	0.49	0.38
Small	0.15	0.25	0.23	0.20	0.23	0.46	0.04	0.07	0.44	0.39
Moderate	0.15	0.11	0.33	0.21	0.25	0.49	0.04	0.07	0.37	0.44
High	0.24	0.20	0.16	0.21	0.12	0.46	0.00	0.00	0.36	0.33
HIV+	0.18	0.24	0.29	0.32	0.23	0.32	0.14	0.00	0.29	0.43

Table B6: Descriptive statistics health questionnaire classified by perceived HIV contamination risk

Perceived HIV Contraction Risk (N)	Medical Insurance	Alternative medical aid	Consultations	Life expectancy	Expected time till death	Smokes	Cigarettes	Ranks Influenza and Pneumonia nr1	Ranks HIV nr1	Ranks TBC nr1[1]
Not at all (52)	0.31	0.13	2.50	72.91	51.51	0.10	11.40	0.08	0.79	0.08
Small (84)	0.39	0.15	2.61	74.63	52.12	0.26	8.60	0.05	0.87	0.14
Moderate (28)	0.18	0.18	2.79	70.81	48.73	0.25	4.14	0.07	0.89	0.11
High (25)	0.28	0.24	2.76	68.88	45.58	0.20	12.30	0.21	0.72	0.17
HIV+ (23)	0.30	0.22	5.18	59.06	34.11	0.22	7.40	0.10	0.52	0.55

	Perceived Probability Influenza or Pneumonia			Perceived Probability HIV/AIDS			Perceived Probability TBC				
Perceived HIV Contraction Risk (N)	own	others	compared to others	own	others	compared to others	own	others	compared to others	Pregnancy	Sexual intercourse
Not at all (52)	1.85	2.44	1.52	1.00	3.08	1.27	1.73	2.60	1.50	0.12	0.71
Small (84)	2.19	2.67	1.60	2.00	3.36	1.27	2.05	2.65	1.46	0.15	0.82
Moderate (28)	2.54	2.93	2.00	3.00	3.68	1.89	2.39	2.89	1.86	0.18	0.89
High (25)	2.28	2.72	1.68	4.00	3.96	2.16	2.80	3.00	1.92	0.24	0.92
HIV+ (23)	2.41	2.86	1.61	5.00	3.52	2.10	2.68	2.96	1.96	0.30	1.00

Perceived HIV Contraction Risk	Uses condoms	Used condom last time	HIV negative	Not tested	Wants HIV test	Prefers not to answer
Not at all	0.86	0.77	0.33	0.63	0.04	0.69
Small	0.89	0.81	0.49	0.48	0.02	0.66
Moderate	0.91	0.83	0.21	0.71	0.07	0.54
High	0.81	0.68	0.24	0.60	0.16	0.64
HIV+	0.95	0.86	-	-	-	-

[1] Some respondents ranked both HIV/AIDS and TBC as number one cause of death. For some groups, the sum of the percentages is larger than 100%.

Appendix C

Experimental Script

Welcome announcement

Thank you for agreeing to participate in this survey. Recall that you will be paid 30 rand for your participation.

We will first come around and distribute an informed consent form and ask each of you to read and sign it verifying that you have read it and understood. This form is used for your protection only.

[DISTRIBUTE INFORMED CONSENT FORM.]

We will now come around and ask each of you to pick a card with an ID number that we will use to keep track of who answered which questions. All records and published results will be linked to anonymous ID numbers only, and not to your name. So this experiment will be anonymous. Please keep your ID numbers private and do not share the information with anyone else.

[DISTRIBUTE ID CARDS.]

You will now be given written instructions and examples for the tasks today that we will be using. We kindly request you not to write on these instructions.

[DISTRIBUTE RISK AVERSION INSTRUCTIONS.]

Before we begin, I would like to ask one person to come up here and inspect the bingo cage that we will use several times during today's session. Please verify that we have here 100 balls numbered from 1 to 100. I will now ask you to place these balls into the bingo cage. Please take your seat again.

WELCOME TO THE EXPERIMENT
THESE ARE YOUR INSTRUCTIONS

This is an experiment in the economics of decision making. Your participation in this experiment is voluntary. However, we think you will find the experiment interesting. You will be paid 30 rand for your participation *and* you could make a considerable amount of additional money. The instructions are simple and you will benefit from following them carefully. Please take a few minutes to read them through together with me.

In this experiment, you may receive some money from us in addition to the guaranteed participation fee. How much you receive will depend partly on chance and partly on the choices you make in the decision problems, which will be presented to you in a few minutes.

The problems are not designed to test you. What we want to know is what choices you would make in them. The only right answer is what you really would choose. That is why the problems give you the chance of winning money.

The decisions are your own decisions. Please do not communicate with anyone else about what you decide.

The experiment will proceed in five parts.

Part I consists of some questions about yourself. Your answers to these questions will be kept confidential and used for statistical purposes only.

Part II and III are decision problems that require you to make a series of economic choices. These problems are described in more detail later. The two decision problems are different, and each of these problems gives you a chance to earn money.

Part IV and V consist of some additional questions about you. Again, this information is for our records only and we assure that your responses will be kept confidential.

At the end, I will ask you to step aside for a moment and then call you back in, one at a time, to pay you in private.

[DISTRIBUTE THE SOCIAL QUESTIONNAIRE]

At this time, I ask that you answer the questions for Part I. Please write down your ID number in the top left corner of the questionnaire. Make sure that you answer all questions.

[COLLECT THE QUESTIONNAIRES BY LETTING THE SUBJECTS PUT THEIR FORM IN A CLOSED BOX. BEFORE, CHECK IF THE ID NUMBER IS CORRECT]

Instructions for Part II

We will now continue with Part II of the experiment.

Each person in this room will have a chance to receive an additional large sum of money. If you are selected to receive this sum of money, the amount that you will receive, depends on the choice you will soon make in this part of the experiment between two payment options; option A or option B. Each person will have a 1-in-10 chance of receiving the money. The selection will be done at the end of this part of the experiment using a 10-sided die, which has 10 numbers from 0 up to 9. If the number 0 is drawn, you will receive the money at the end of the meeting. If any other number is drawn, you will not receive the money.

First, you will be asked to make a series of choices in one decision problem. The table shown below is an illustration of what the decision problem will look like.

Example

Decision	Option A	Option B	Your Choice (Circle A or B)
1	2.00 rand if ball is 1-10 1.60 rand if ball is 11-100	3.85 rand if ball is 1-10 0.10 rand if ball is 11-100	A B
2	2.00 rand if ball is 1-20 1.60 rand if ball is 21-100	3.85 rand if ball is 1-20 0.10 rand if ball is 21-100	A B
3	2.00 rand if ball is 1-30 1.60 rand if ball is 31-100	3.85 rand if ball is 1-30 0.10 rand if ball is 31-100	A B
4	2.00 rand if ball is 1-40 1.60 rand if ball is 41-100	3.85 rand if ball is 1-40 0.10 rand if ball is 41-100	A B
5	2.00 rand if ball is 1-50 1.60 rand if ball is 51-100	3.85 rand if ball is 1-50 0.10 rand if ball is 51-100	A B
6	2.00 rand if ball is 1-60 1.60 rand if ball is 61-100	3.85 rand if ball is 1-60 0.10 rand if ball is 61-100	A B
7	2.00 rand if ball is 1-70 1.60 rand if ball is 71-100	3.85 rand if ball is 1-70 0.10 rand if ball is 71-100	A B
8	2.00 rand if ball is 1-80 1.60 rand if ball is 81-100	3.85 rand if ball is 1-80 0.10 rand if ball is 81-100	A B
9	2.00 rand if ball is 1-90 1.60 rand if ball is 91-100	3.85 rand if ball is 1-90 0.10 rand if ball is 91-100	A B
10	2.00 rand if ball is 1-100	3.85 rand if ball is 1-100	A B

The table shows ten decisions listed on the left side, in the column marked **Decision**. Each decision is a paired choice between "Option A" and "Option B." You will be asked to make a choice between these two options in each decision row.

Before you start thinking about your choice, let me explain how your choice affects your earnings. Earnings depend partly on the outcome of a spin of the bingo cage you see in this room. When the bingo cage is spun, a single ball will be randomly picked from all the balls in the bingo cage, and the number on the ball will in part determine your earnings. The bingo cage contains 100 balls, which are individually numbered from 1 to 100, so any number from 1 to 100 is equally likely to be chosen.

Please look at decision 1 at the top of the table. Option A pays 2 rand if the bingo ball is number 10 or lower, and it pays 1.60 rand if the bingo ball is number 11 or higher. This means that there is a 10-in-100 chance of getting 2 rand and a 90-in-100 chance of getting 1.60 rand.

Option B in decision 1 at the top of the table pays 3.85 rand if the bingo ball is number 10 or lower, and it pays 0.10 rand if the bingo ball is number 11 or higher.

The other decisions are similar, except that as you move down the table, the chances of receiving the higher payoff for each option increase. In fact, for decision 10 in the bottom row, the bingo cage will not be needed since each option pays the highest payoff for sure. So your choice in decision 10 is simply between
2 or 3.85 rand.

For each of the ten decisions, you will be asked to choose Option A or Option B by circling the appropriate letter, A or B. The letters are shown on the right side of the table. What kind of decision you make is entirely up to you.

Which decision row will be selected for possible payment?

As you can see, you have 10 decisions to make. However, we will pay you for only one of these decisions. After you have made all of your choices, I will use the bingo cage to select which decision will be used to determine your possible payment. To decide which decision row will determine your payment; I will spin the bingo cage and withdraw one ball. The number on the bingo ball determines the decision row you will play out. Thus if the number is 1 to 10 you will play out decision row 1, if the number is 11 to 20 you will play out decision 2, and so on. Each decision row is therefore equally likely to be chosen.

Which amount will be selected for possible payment?

Once we know which row is selected, I will spin the bingo cage to see if you will receive the higher amount or the lower amount for the choice that you made. Thus if you chose Option A, you would be paid the appropriate amount in Option A; if you chose Option B, you would be paid the appropriate amount in Option B.

In which case will you receive additional money?

Finally, to determine whether or not you will receive the earnings at the end of the section, you will roll a 10-sided die. If the number 0 is drawn, you will receive the payment. If any other number is drawn, you will not receive the payment.

[HANDOUT THE EXAMPLE.]

Example

To illustrate our procedures, we will now continue with an example where the payments are indicated in sweets. You will be asked to make choices in one problem. After you have completed your choices I will perform all the draws using the bingo cage to determine your payments.

Each person will have a 1-in-10 chance of receiving the sweets. This last selection will be done using a 10-sided die. If the number 0 is drawn, you will receive the sweets immediately. If any other number is drawn, you will not receive the sweets.

At this time, I ask that you fill out the record sheet for this example. Please write your ID number in the top left corner of the record sheet. Make a choice for Option A or B in each decision row.

[If you have a question, please raise your hand and we will come to help you. When you are finished, please put down your pen and wait for further instructions.]

EXPERIMENTER SCRIPT

[EXPERIMENTER USES RECORD SHEET AND BLACKBOARD.]

I will first spin the bingo cage to determine which decision row is the binding one for payment.

[SPIN BINGO CAGE.]

The number is [X] and therefore row [XX] has been selected. Please write down the number of the ball in the first line below the table, and the number of the decision row that has been selected in the second line. Make sure you understood how this row has been selected.

Now, I will spin the bingo cage to determine whether you will receive the higher amount or the lower amount.

[SPIN BINGO CAGE.]

The number is [Y]. Please write this number in the third line and determine what your earnings would be. Write this down in the fourth line.

Finally, we will now come around and let you roll the 10-sided die as soon as we tell you to do so, to determine who will receive the sweets. If the number 0 is drawn, you will receive the sweets immediately. If any other number is drawn, you will not receive the sweets.

We will also check if the form is filled out correctly.

[ROLL 10-SIDED DIE FOR EACH PERSON AND CHECK RECORDSHEETS FOR CORRECTNESS]

Is this procedure clear to everyone?

We will now proceed with Part II of the experiment. You will be asked to make choices in one decision problem on the record sheet that we will distribute to you in a moment.

After you have completed the problem, I will perform the random draws using the bingo cage to determine your possible payments for this part.

Each person will have a 1-in-10 chance of actually receiving the money. The selection will be done using a 10-sided die. If the number 0 is drawn, you will receive the money at the end of the meeting. If any other number is drawn, you will not receive the money.

All payments are made in private so other people will not know your decisions.

[DISTRIBUTE RECORD SHEETS TO SUBJECTS.]

At this time, we ask that you fill out the record sheet for this decision problem. Please write your ID number in the top left corner of the record sheet. Make a choice for Option A or B in each decision row.

When you are finished, please put down your pen and wait for further instructions.

EXPERIMENTER SCRIPT

[EXPERIMENTER USES RECORD SHEET AND BLACKBOARD.]

I will first spin the bingo cage to determine which decision row is the binding one for payment.

[SPIN BINGO CAGE.]

The number is [X] and therefore row [XX] has been selected. Please write down the number of the ball in the first line below the table, and the number of the decision row that has been selected in the second line. Make sure you understood how this row has been selected.

I will then spin the bingo cage to determine whether you will receive the higher amount or the lower amount.

[SPIN CAGE WITH 100 BALLS.]

The number is [Y]. Please write this number in the third line and determine what your earnings would be. Write this down in the fourth line.

Finally, we will now come around and let you roll the 10-sided die to determine who will receive the money. If the number 0 is drawn, you will receive the money at the end of the meeting. If any other number is drawn, you will not receive the money.

[ROLL 10-SIDED DIE FOR EACH PERSON, CHECK RECORDSHEETS FOR CORRECTNESS, AND COLLECT THEM, AND PUT THE PILE OF SHEETS VISIBLY ON THE TABLE.]

Experimenter script for IDR tasks

We will now proceed with Part III of the experiment.

[GIVE HANDOUTS TO SUBJECTS: PART III DISCOUNT RATE INSTRUCTIONS.]

Instructions for Part III

Each person in this room will have a chance to receive an additional large sum of money. If you are selected to receive this sum of money, the amount that you will receive, depends on the choice you will soon make in this part of the experiment between two payment options; option A or option B. Each person will have a 1-in-10 chance of receiving the money. The selection will again be done using a ten-sided die. If the number 0 is drawn, you will receive the money. If any other number is drawn, you will not receive the money.

You will be asked to make a series of choices in one decision problem. The table shown below is an illustration of what the decision problem will look like.

Example

Decision	Option A To be paid in 1 month	Option B To be paid in 7 months	Annual interest rate
1	R 100	R 101,51	5%
2	R 100	R 105,04	6%
3	R 100	R 108,55	9%
4	R 100	R 106,09	12%
5	R 100	R 107,64	15%
6	R 100	R 109,20	18%
7	R 100	R 110,78	21%
8	R 100	R 112,36	24%
9	R 100	R 113,96	27%
10	R 100	R 115,56	30%
11	R 100	R 117,18	33%
12	R 100	R 118,81	36%
13	R 100	R 120,45	39%
14	R 100	R 122,10	42%
15	R 100	R 123,77	45%
16	R 100	R 125,44	48%
17	R 100	R 127,13	51%
18	R 100	R 128,83	54%
19	R 100	R 130,55	57%
20	R 100	R 132,28	60%

The table shows twenty decisions listed on the left side, in the column marked **Decision**. Each decision is a paired choice between Option A and Option B. You will be asked to make a choice between these two payment options in each decision row. In this example each of the 20 decision rows will pay 100 rand one month from today (option A) and 100 + *X* rand seven months from today (option B), where *X* rand differs in each decision row.

Please look at decision 1 at the top of the table. Option A pays 100 rand one month from today, and Option B pays 101.51 rand seven months from today. In this example, if you choose Option B instead of option A, you will receive an annual interest rate of 3% by delaying the payment by six months. The other decisions are similar, except that as you move down the table the annual interest rate on the amount in Option B increases.

For each of the 20 decisions, you will be asked to choose Option A or Option B by circling the appropriate letter, A or B. The letters are shown on the right side of the table. What kind of decision you make is entirely up to you.

As you can see, you have 20 decisions to make. However, we will pay you for only one of these decisions. After you have made all of your choices, I will again use the bingo cage to select which decision will be used to determine your payment. These procedures will work in a similar way as in Part II of the experiment.

Again, the number on the bingo ball determines the decision row you will play out. In this case, if the number is 1 to 5, you will play out decision row 1, if the number is 6 to 10, you will play out decision 2, and so on. Each decision row is therefore equally likely to be chosen.

There is one final detail I need to explain. You will be asked to complete six decision problems as explained above. These six decisions will be exactly the same except that the payment date for Option B will differ.

Although you will complete six problems, we will not pay you for all six problems. After you have completed the entire set of decision problems I will ask one of you to come up here and roll a six sided die to determine which of the problems that will be used for your possible payment. If the number on the die is 1 you will be paid according to your choice in the first problem; if the number is 2, you will be paid according to your choice in the second problem, and so on. Once we have selected the decision problem to be played out, I will spin the bingo cage as explained earlier on.

It is important to understand that you will have to finish making your choices for all six problems before I conduct the random draws.

HOW WILL YOU BE PAID FOR PART III OF THIS EXPERIMENT?

If your last throw is 0, you will receive a post-dated check that is redeemable under the conditions dictated by your chosen payment option in the selected payoff alternative. The check is issued by Tilburg University, the Netherlands, which is a trusted partner by Northwest University. You can cash in the check at any time after the specified date, and at any Standard Bank in South Africa.

We will now proceed with Part III of the experiment. Recall that you will be asked to make choices in six decision problems, like the one I have demonstrated. After you have completed all six problems, we will perform the random draws using the six-sided die and the bingo cage to determine your possible payments for this part of the experiment.

Each person will have a 1-in-10 chance of receiving the money. The selection will be done using a ten-sided die. If the number 0 is drawn, you will receive the money at the agreed date. If any other number is drawn, you will not receive the money.

All payments are made in private so other people will not know your decisions.

[DISTRIBUTE RECORD SHEETS TO SUBJECTS

At this time, we ask that you fill out the record sheets for the decision problems. Please write down your ID number in the top left corner of the record sheet. Make sure you fill in every decision row for all six tables.

When you are finished, please put down your pen and wait for further instructions.

EXPERIMENTER SCRIPT

[EXPERIMENTER USES RECORD SHEETS AND BLACKBOARD.]

I would like one person to come up here and roll the six-sided die to determine which of the six problems will be used for your payment.

[SUBJECT ROLLS SIX-SIDED DIE.]

The number is [X] and therefore problem [X] has been selected. Please write this down in the first line below the table.

Please take your seat again.

I will next spin the bingo cage to determine which decision row is the binding one for payment.

[SPIN BINGO CAGE.]

The number is [YY] and therefore decision row number [Y] has been selected. Please write down the number of the ball in the second line below the table, and the number of the decision row that has been selected in the third line. Also write down the earnings that you have chosen

Finally, we will now come around and let you roll the ten-sided die to determine who will receive the money. If the number 0 is drawn, you will receive the money at the agreed date. If any other number is drawn, you will not receive the money.

[ROLL TEN-SIDED DIE FOR EACH PERSON, CHECK RECORD SHEETS FOR CORRECTNESS, COLLECT THEM AND PUT THEM VISIBLY ON THE TABLE]

At this time, I ask that you answer the questions for Part IV and V.

This information is for our records only and your responses will be kept confidential. Like in part I, we will let you put your forms in the closed box to assure your answers are anonymous. Please write your ID number in the top left corner of the record sheet and make sure that you give an answer to all questions.

[DISTRIBUTE PART IV: QUESTIONNAIRE CONCERNING FINANCIAL.]

[COLLECT THE QUESTIONNAIRS BY LETTING THE SUBJECTS PUT THEIR FORM IN A CLOSED BOX. BEFORE, CHECK IF THE ID NUMBER IS CORRECT]

When you are finished, please put down your pen and wait until your questionnaire is collected by one of us.

This is the end of the survey. I will ask you to step aside for a moment and then call you back in, one at a time, to pay you in private.

Thank you for participating in the survey.

Appendix D

Experimental Tasks

D.1 Risk aversion tasks

ID number: _____ Example

Decision	Option A	Option B	Your Choice (Circle A or B)
1	6 sweets if ball is 1-10 4 sweets if ball is 11-100	10 sweets if ball is 1-10 1 sweet if ball is 11-100	A B
2	6 sweets if ball is 1-20 4 sweets if ball is 21-100	10 sweets if ball is 1-20 1 sweet if ball is 21-100	A B
3	6 sweets if ball is 1-30 4 sweets if ball is 31-100	10 sweets if ball is 1-30 1 sweet if ball is 31-100	A B
4	6 sweets if ball is 1-40 4 sweets if ball is 41-100	10 sweets if ball is 1-40 1 sweet if ball is 41-100	A B
5	6 sweets if ball is 1-50 4 sweets if ball is 51-100	10 sweets if ball is 1-50 1 sweet if ball is 51-100	A B
6	6 sweets if ball is 1-60 4 sweets if ball is 61-100	10 sweets if ball is 1-60 1 sweet if ball is 61-100	A B
7	6 sweets if ball is 1-70 4 sweets if ball is 71-100	10 sweets if ball is 1-70 1 sweet if ball is 71-100	A B
8	6 sweets if ball is 1-80 4 sweets if ball is 81-100	10 sweets if ball is 1-80 1 sweet if ball is 81-100	A B
9	6 sweets if ball is 1-90 4 sweets if ball is 91-100	10 sweets if ball is 1-90 1 sweet if ball is 91-100	A B
10	6 sweets if ball is 1-100	10 sweets if ball is 1-100	A B

Outcomes of random draws for decision problem

BALL NUMBER DECISIVE FOR DECISION ROW: _____

SELECTED DECISION ROW: _____

BALL NUMBER DECISIVE FOR PAYMENT: _____

SELECTED EARNINGS: _____

RESULT OF 10 SIDED DIE ROLL: _____
(0 means you will be paid the amount for this task)

ID number: _____ Part II

Decision	Option A	Option B	Your Choice (Circle A or B)
1	50.00 rand if ball is 1-10 40.00 rand if ball is 11-100	96.25 rand if ball is 1-10 2.50 rand if ball is 11-100	A B
2	50.00 rand if ball is 1-20 40.00 rand if ball is 21-100	96.25 rand if ball is 1-20 2.50 rand if ball is 21-100	A B
3	50.00 rand if ball is 1-30 40.00 rand if ball is 31-100	96.25 rand if ball is 1-30 2.50 rand if ball is 31-100	A B
4	50.00 rand if ball is 1-40 40.00 rand if ball is 41-100	96.25 rand if ball is 1-40 2.50 rand if ball is 41-100	A B
5	50.00 rand if ball is 1-50 40.00 rand if ball is 51-100	96.25 rand if ball is 1-50 2.50 rand if ball is 51-100	A B
6	50.00 rand if ball is 1-60 40.00 rand if ball is 61-100	96.25 rand if ball is 1-60 2.50 rand if ball is 61-100	A B
7	50.00 rand if ball is 1-70 40.00 rand if ball is 71-100	96.25 rand if ball is 1-70 2.50 rand if ball is 71-100	A B
8	50.00 rand if ball is 1-80 40.00 rand if ball is 81-100	96.25 rand if ball is 1-80 2.50 rand if ball is 81-100	A B
9	50.00 rand if ball is 1-90 40.00 rand if ball is 91-100	96.25 rand if ball is 1-90 2.50 rand if ball is 91-100	A B
10	50.00 rand if ball is 1-100	96.25 rand if ball is 1-100	A B

Outcomes of random draws for decision problem

BALL NUMBER DECISIVE FOR DECISION ROW: _____

SELECTED DECISION ROW: _____

BALL NUMBER DECISIVE FOR PAYMENT: _____

SELECTED EARNINGS: _____

RESULT OF 10 SIDED DIE ROLL: _____
(0 means you will be paid the amount for this task)

D.2 Discount rate tasks

ID number: _____ Part III

Problem 1

Decision	Option A To be paid in 1 month	Option B To be paid in 2 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 172,43	3%	A B
2	R 172	R 172,86	6%	A B
3	R 172	R 173,28	9%	A B
4	R 172	R 173,70	12%	A B
5	R 172	R 174,12	15%	A B
6	R 172	R 174,54	18%	A B
7	R 172	R 174,96	21%	A B
8	R 172	R 175,37	24%	A B
9	R 172	R 175,79	27%	A B
10	R 172	R 176,20	30%	A B
11	R 172	R 176,61	33%	A B
12	R 172	R 177,01	36%	A B
13	R 172	R 177,42	39%	A B
14	R 172	R 177,82	42%	A B
15	R 172	R 178,22	45%	A B
16	R 172	R 178,62	48%	A B
17	R 172	R 179,02	51%	A B
18	R 172	R 179,42	54%	A B
19	R 172	R 179,81	57%	A B
20	R 172	R 180,20	60%	A B

Problem 2

Decision	Option A To be paid in 1 month	Option B To be paid in 5 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 173.72	3%	A B
2	R 172	R 175.45	6%	A B
3	R 172	R 177.18	9%	A B
4	R 172	R 178.91	12%	A B
5	R 172	R 180.65	15%	A B
6	R 172	R 182.40	18%	A B
7	R 172	R 184.14	21%	A B
8	R 172	R 185.90	24%	A B
9	R 172	R 187.65	27%	A B
10	R 172	R 189.41	30%	A B
11	R 172	R 191.18	33%	A B
12	R 172	R 192.94	36%	A B
13	R 172	R 194.72	39%	A B
14	R 172	R 196.49	42%	A B
15	R 172	R 198.27	45%	A B
16	R 172	R 200.06	48%	A B
17	R 172	R 201.84	51%	A B
18	R 172	R 203.64	54%	A B
19	R 172	R 205.43	57%	A B
20	R 172	R 207.23	60%	A B

Problem 3

Decision	Option A To be paid in 1 month	Option B To be paid in 7 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 174.59	3%	A B
2	R 172	R 177.20	6%	A B
3	R 172	R 179.83	9%	A B
4	R 172	R 182.47	12%	A B
5	R 172	R 185.14	15%	A B
6	R 172	R 187.83	18%	A B
7	R 172	R 190.53	21%	A B
8	R 172	R 193.26	24%	A B
9	R 172	R 196.00	27%	A B
10	R 172	R 198.77	30%	A B
11	R 172	R 201.55	33%	A B
12	R 172	R 204.35	36%	A B
13	R 172	R 207.18	39%	A B
14	R 172	R 210.02	42%	A B
15	R 172	R 212.88	45%	A B
16	R 172	R 215.76	48%	A B
17	R 172	R 218.66	51%	A B
18	R 172	R 221.57	54%	A B
19	R 172	R 224.51	57%	A B
20	R 172	R 227.47	60%	A B

Problem 4

Decision	Option A To be paid in 1 month	Option B To be paid in 13 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 177.22	3%	A B
2	R 172	R 182.55	6%	A B
3	R 172	R 188.01	9%	A B
4	R 172	R 193.59	12%	A B
5	R 172	R 199.29	15%	A B
6	R 172	R 205.11	18%	A B
7	R 172	R 211.07	21%	A B
8	R 172	R 217.15	24%	A B
9	R 172	R 223.36	27%	A B
10	R 172	R 229.70	30%	A B
11	R 172	R 236.18	33%	A B
12	R 172	R 242.79	36%	A B
13	R 172	R 249.54	39%	A B
14	R 172	R 256.44	42%	A B
15	R 172	R 263.47	45%	A B
16	R 172	R 270.65	48%	A B
17	R 172	R 277.97	51%	A B
18	R 172	R 285.44	54%	A B
19	R 172	R 293.06	57%	A B
20	R 172	R 300.83	60%	A B

Problem 5

Decision	Option A To be paid in 1 month	Option B To be paid in 18 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 179.89	3%	A B
2	R 172	R 188.07	6%	A B
3	R 172	R 196.57	9%	A B
4	R 172	R 205.38	12%	A B
5	R 172	R 214.51	15%	A B
6	R 172	R 223.99	18%	A B
7	R 172	R 233.81	21%	A B
8	R 172	R 243.99	24%	A B
9	R 172	R 254.53	27%	A B
10	R 172	R 265.45	30%	A B
11	R 172	R 276.76	33%	A B
12	R 172	R 288.46	36%	A B
13	R 172	R 300.58	39%	A B
14	R 172	R 313.11	42%	A B
15	R 172	R 326.08	45%	A B
16	R 172	R 339.50	48%	A B
17	R 172	R 353.37	51%	A B
18	R 172	R 367.71	54%	A B
19	R 172	R 382.53	57%	A B
20	R 172	R 397.85	60%	A B

Problem 6

Decision	Option A To be paid in 1 month	Option B To be paid in 24 months	Annual Interest rate	Your choice (Circle A or B)
1	R 172	R 182.60	3%	A B
2	R 172	R 193.76	6%	A B
3	R 172	R 205.51	9%	A B
4	R 172	R 217.88	12%	A B
5	R 172	R 230.90	15%	A B
6	R 172	R 244.60	18%	A B
7	R 172	R 259.00	21%	A B
8	R 172	R 274.14	24%	A B
9	R 172	R 290.05	27%	A B
10	R 172	R 306.76	30%	A B
11	R 172	R 324.30	33%	A B
12	R 172	R 342.72	36%	A B
13	R 172	R 362.05	39%	A B
14	R 172	R 382.32	42%	A B
15	R 172	R 403.58	45%	A B
16	R 172	R 425.87	48%	A B
17	R 172	R 449.22	51%	A B
18	R 172	R 473.69	54%	A B
19	R 172	R 499.32	57%	A B
20	R 172	R 526.15	60%	A B

Record sheet for Part III

Outcomes of random draws for decision problem

PROBLEM CHOSEN BY DIE: _____

BALL NUMBER DECISIVE FOR DECISION ROW: _____

SELECTED DECISION ROW: _____

SELECTED EARNINGS: _____

RESULT OF 10 SIDED DIE ROLL: _____
(0 means you will be paid the amount for this task)

Appendix E

Questionnaires

E.1 Socio-demographic questionnaire

ID number: _____ Part I

Some questions about you

In this survey most of the questions asked are descriptive. The questions may seem personal, but they will help us analyze the results of the experiments. Your responses are completely confidential. Please think carefully about each question and give your best answer.

1. What is your age? _____ years

---

2. What is your gender? (Circle one number)

01 Male
02 Female

---

3. Which of the following categories best describes you? (Circle one number)

01 Black African
02 Colored
03 Indian or Asian
04 White
05 Other (specify) _____

---

4. Where have you lived most of your life? (Circle one number)

01 Mafikeng
02 North West province (urban area, but not afikeng)
03 North West province (rural area)
04 Other province of South Africa (urban area)
05 Other province of South Africa (rural area)
06 Botswana (urban)
07 Botswana (rural)
08 Other (specify) _____

5. What is your field of study? (Circle one number)

01 Commerce and Administration
02 Agriculture sciences (e.g. agricultural economics, animal health/production, crop science)
03 Science and Technology (e.g. Biology, Chemistry, Nursing science, Physics)
04 Law
05 Educational sciences
06 Human and Social Sciences
07 Other fields (specify) _____

6. What is your year of study? (Circle one number)

01 First year
02 Second year
03 Third year
04 Fourth year/Honors
05 Masters
06 Doctoral/PhD

7. What is your marital status? (Circle one number)

01 Married
02 Cohabit (living together)
03 Divorced
04 Single

8. Do you have a family of your own? (Circle one number)

01 Yes
02 No, I live on my own
03 No, I live with my parent(s) (or other relatives, or guardian)

9. What is the size of the family you are living in?

_____ Adults (18 and older)
_____ Children (younger than 18)

10. In which type of dwelling or housing unit are you living? (Circle one number)

01 Informal dwelling e.g. hut, shack, dwelling made of traditional materials
02 Flat/apartment
03 House of brick structure e.g. (semi-) detached house, in townhouse complex
04 House of brick structure on separate stand or yard
05 Student's residence e.g. hostel, student house
06 Other (specify) _____

11. What is the tenure status of this dwelling or housing unit? (Circle one number)

01 Owned and fully paid off
02 Owned but not yet paid off
03 Rented
04 Occupied rent-free
05 Other (specify) _____

12. What was the amount of total income earned in 2004 by your household (you and all members of your family)? (Circle one number)

[Consider all forms of income.]

01 R 0 - R 4.800
02 R 4.801 - R 9.600
03 R 9.601 - R 38.400
04 R 38.401 - R 76.800
05 R 76.801 - R 153.600
06 R 153.601 - R 614.400
07 R 614.401 or more

13. What is the main source of finance for your tuition fee at North-West University? (Circle one number)

01 Yourself
02 Your parents/guardians
03 Bursary/scholarship
04 Loan
05 Other (specify) _____

The next questions are related to the household in which you lived when you were 15 years old (presumably with at least one of your parents, but it could also be with other relatives or a guardian).

14. How many adults and children (including yourself) were living in this household?

_____ adults (18 and older)
_____ children (younger than 18)

---

15. In which type of dwelling or housing unit were you living then? (Circle one number)

01 Informal dwelling e.g. hut, shack, dwelling made of traditional materials
02 Flat/apartment
03 House of brick structure e.g. (semi-) detached house, in townhouse complex
04 House of brick structure on separate stand or yard
05 Other (specify) _____

---

16. What was the tenure status of this dwelling or housing unit? (Circle one number)

01 Owned
02 Rented
03 Occupied rent-free
04 Other (specify) _____
05 Don't know

17. How can one best describe the main activity or work status of the highest income earner of this household? (Circle one number)

01 Formally employed (monthly income)
02 Informally employed/contract worker
03 Owner on a registered business
04 Owner on an informal business
05 Unemployed and able to work
06 Unemployed and not able to work (because e.g. illness or disability)
07 Retired

---

18. What is the highest level of education that the main income earner of this household had completed? (Circle one number)

01 No schooling
02 Pre-school
03 School (primary education)
04 High school (secondary education)
05 Technikon /college
06 University
07 Adult education center
08 Other (specify) _____

---

19. How would you describe the income position of this household compared to other South African households at that time? (Circle one number)

01 Low income group
02 Middle income group
03 High income group

20. **Suppose you win R 650 today. What would you plan to do with the money? (Circle one number)**

01 I will keep everything for myself
02 I will give less than half of it to relatives/friends
03 I will give half or more of it to relatives/friends
04 I will give everything to relatives/friends
→ End of part I

21. **For the part of the R 650 that you keep for yourself, what will you do with it? (Circle one number)**

01 I will spend everything
02 I will save less than half of it
03 I will save more than half of it

---End of Part I---

→ Go to question 4

E.2 Financial questionnaire

ID number: _____ Part IV

Some questions about you

In this survey most of the questions asked are descriptive. The questions may seem personal, but they will help us analyze the results of the experiments. Your responses are completely confidential. Please think carefully about each question and give your best answer.

1. Do you save? (Circle one number)

01 Yes
02 No → Go to question 4

---

2. Which of the following informal (non-banking) saving methods do you use? (Circle one or more numbers)

01 Keep it at home
02 Stokvel
03 Give to relative or friend to keep safe
04 In community
05 Other (specify) _____
06 Do not use informal saving methods

---

3. Do you have a savings account? (Circle one number)

01 Yes
02 No → Go to question 4

A. If yes, what (annual) interest rate does your savings account currently earn? (Give your best estimate)

_____ percent
_____ don't know

B. **What is the current balance on your savings account? (Circle one number)**

01 R 250 or less
02 R 251 – R 500
03 R 501 – R 1.000
04 R 1.001 – R 2.500
05 R 2.501 or more
08 Don't know

---

4. **Do you have an overdraft/line of credit (not a credit card)? (Circle one number)**

01 Yes
02 No → Go to question 5

A. **If yes, what (annual) interest rate do you currently pay on this overdraft? (Give your best estimate)**

_____ percent
_____ don't know

B. **Do you use this overdraft on a monthly basis? (Circle one number)**

01 Yes
02 No → Go to question 5

C. **If yes, what is the current balance owed on this overdraft? (Circle one number)**

01 R 250 or less
02 R 251 – R 500
03 R 501 – R 1.000
04 R 1.001 – R 2.500
05 R 2.501 or more
08 Don't know

5. **Do you have a credit card? (Circle one number)**

01 Yes
02 No → Go to question 6

A. **If yes, what (annual) interest rate do you currently pay on your credit card? (Give your best estimate)**

_____ percent
_____ don't know

B. **What is the balance owed on this credit card? (Circle one number)**

01 R 250 or less
02 R 251 – R 500
03 R 501 – R 1.000
04 R 1.001 – R 2.500
05 R 2.501 or more
08 Don't know

---

6. **Do you have a credit/store card from retailers e.g. JET Stores, Truworths, Edgars? (Circle one number)**

01 Yes
02 No → Go to question 7

A. **If yes, what (annual) interest rate do you currently pay on this credit/store card? (Give your best estimate)** *(If you have more than one credit/store card from retailers, please consider the card with the highest annual interest rate.)*

_____ percent
_____ don't know

B. **What is the balance owed on this credit/store card? (Circle one number)**

01 R 250 or less
02 R 251 – R 500
03 R 501 – R 1.000
04 R 1.001 – R 2.500
05 R 2.501 or more
08 Don't know

---

7. **Do you owe money on a student loan? (Circle one number)**

01 Yes
02 No → Go to question 8

A. **If yes, what is the (annual) interest rate on your student loan? (Give your best estimate)**

_____ percent
_____ don't know

B. **What is the balance owed on your student loan? (Circle one number)**

01 R 500 or less
02 R 501 – R 1.000
03 R 1.001 – R 2.500
04 R 2.501 – R 5.000
05 R 5.001 – R 10.000
06 R 10.001 or more
08 Don't know

---

8. **Do you owe money on a micro loan? (Circle one number)**

01 Yes
02 No → Go to question 9

A. **If yes, what is the (annual) interest rate on this micro loan? (Give your best estimate)**

_____ percent
_____ don't know

B. **What is the balance owed on this micro loan? (Circle one number)**

01 R 500 or less
02 R 501 – R 1.000
03 R 1.001 – R 2.500
04 R 2.501 – R 5.000
05 R 5.001 – R 10.000
06 R 10.001 or more
08 Don't know

---

9. **Do you have an investment account? (Circle one number)**

01 Yes (specify) _____
02 No → Go to question 10

A. **If yes, what (annual) interest rate does your investment account currently earn? (Give your best estimate)**
(If you have more than one investment account, please consider the account currently earning the highest annual interest rate.)

_____ percent
_____ don't know

B. **What is the current balance on this investment account? (Circle one number)**

01 R 500 or less
02 R 501 – R 1.000
03 R 1.001 – R 2.500
04 R 2.501 – R 5.000
05 R 5.001 – R 10.000
06 R 10.001 or more
08 Don't know

10. **If you were to go to the bank to obtain a loan, what do you think your chances would be of being approved? (Circle one number)**

01	At least 90% likely
02	At least 75% likely
03	At least 50% likely
04	At least 25% likely
05	Less than 25% likely

11. **Would you say that you are financially better off or worse off than you were: (Make a choice for each option from A-F)**

	Better now	Same	Worse now	Don't know
A 1 month ago				
B 4 months ago				
C 6 months ago				
D 12 months ago				
E 18 months ago				
F 24 months ago				

12. **Looking at the economic conditions in South Africa as a whole, would you say that at the present time economic conditions are better or worse than they were: (Make a choice for each option from A-F)**

	Better now	Same	Worse now	Don't know
A 1 month ago				
B 4 months ago				
C 6 months ago				
D 12 months ago				
E 18 months ago				
F 24 months ago				

13. **Now looking ahead, do you expect any major change in your situation that will lead to higher expenses or lower expenses during the next: (Make a choice for each option from A-F)**

	Higher expenses	No change	Lower expense	Don't know
A 1 month				
B 4 months				
C 6 months				
D 12 months				
E 18 months				
F 24 months				

14. **Looking ahead, do you expect any major changes in your family situation that will lead to higher *earnings* or lower *earnings* during the next: (Make a choice for each option from A-F)**

	Higher earnings	No change	Lower earnings	Don't know
A 1 month				
B 4 months				
C 6 months				
D 12 months				
E 18 months				
F 24 months				

15. In total, do you think that you will be better off or worse off financially: (Make a choice for each option from A-F)

	Will be better off	Same	Will be worse off	Don't know
A 1 month				
B 4 months				
C 6 months				
D 12 months				
E 18 months				
F 24 months				

16. Do you think that there will be more or less unemployment in South Africa during the next: (Make a choice for each option from A-F)

	More unemployment	About the Same	Less unemployment	Don't know
A 1 month				
B 4 months				
C 6 months				
D 12 months				
E 18 months				
F 24 months				

17. Do you think that the general interest rates in South Africa will go up or go down during the next: (Make a choice for each option from A-F)

	Go up	Stay the same	Go down	Don't know
A 1 month				
B 4 months				
C 6 months				
D 12 months				
E 18 months				
F 24 months				

---End of Part IV---

E.3 Health questionnaire

ID number: _____ Part V

Some questions about you

In this survey most of the questions asked are descriptive. The questions may seem personal, but they will help us analyze the results of the experiments. Your responses are completely confidential. Please think carefully about each question and give your best answer.

1. Do you have medical aid? (Circle one number)

01 Yes
02 No

2. What do you prefer for medical consultation? (Circle one number)

01 Doctor
02 Pharmacist
03 Local clinic
04 Sangoma/traditional healer
05 Other (specify) _____

3. How often in the past year have you been there for own consultation?

01 0 times
02 1 time
03 2 to 5 times
04 5 to 10 times
05 more than 10 times

4. How old do you think, you will become? _____ years

5. What is your height?

01 _____ cm
02 I prefer not to answer this question

6. **What is your weight?**

01 _____ kg
02 I prefer not to answer this question

---

7. **A. Do you currently smoke cigarettes? (Circle one number)**

01 Yes
02 No

B. If yes, how much do you smoke in one day?_____cigarettes

---

8. **Rank the following causes of death in the North West Province in the age group 15-49 years. (Indicate the highest ranked with 1, the second highest with 2, and the lowest with 3)**

Influenza and pneumonia _____
HIV/AIDS related diseases _____
Tuberculosis _____

---

9. **A. What do you think your chances are of getting influenza or pneumonia? (Circle one number)**

01 No risk at all
02 Small
03 Moderate
04 High

B. What do you think the chances are for other students at your university of getting influenza or pneumonia? (Circle one number)

01 No risk at all
02 Small
03 Moderate
04 High

C. What do you think your chances are <u>compared to</u> other students at your university of getting influenza or pneumonia? (Circle one number)

01 Lower
02 About the same
03 Higher

---

10. **A. What do you think your chances are of getting HIV/AIDS? (Circle one number)**

01 No risk at all
02 Small
03 Moderate
04 High

B. What do you think the chances are for other students at your university of getting HIV/AIDS? (Circle one number)

01 No risk at all
02 Small
03 Moderate
04 High

C. What do you think your chances are <u>compared to</u> other students at your university of getting HIV/AIDS? (Circle one number)

01 Lower
02 About the same
03 Higher

---

11. **A. What do you think your chances are of getting Tuberculosis? (Circle one number)**

01 No risk at all
02 Small
03 Moderate
04 High

B. What do you think the chances are for other students at your university of getting Tuberculosis? (Circle one number)

01 No risk at all
02 Small
03 Moderate
04 High

C. What do you think your chances are compared to other students at your university of getting Tuberculosis? (Circle one number)

01 Smaller
02 About the same
03 Higher

---

12. Have you ever been (or made someone) pregnant? (Circle one number)

01 Yes
02 No

---

13. A. Do you use any methods that prevent pregnancy or sexual diseases?

01 Yes
02 No → Go to question 14
03 I have never had sexual intercourse → Go to question 14

B. If yes, do you regularly use condoms?

01 Yes
02 No

C. The last time you had sexual intercourse, did you use a condom? (Circle one number)

01 Yes
02 No

14. Have you ever been tested for HIV?

01 Yes, my status was HIV positive
02 Yes, my status was HIV negative
03 No, I have never been tested.
04 I prefer not to answer this question

---

15. If we could provide you with an HIV test today, would you be interested to know whether or not you are HIV positive? (Circle one number)

01 Yes
02 No

---End of Part V---

Appendix F

Glossary

Affected household: An affected household in the most limited definition is a household that consists of at least one infected member. In the broadest definition every household in the hardest hit countries are affected since the far-reaching consequences of the disease in society. In this dissertation, the most limited definition is used.

AIDS: Acquired Immune Deficiency Syndrome.

$CD4^+$ cell count: Indicator of how healthy the immune system is, indicated in cells per mm^3, measured by taking blood samples. CD4 positive T-lymphocytes ($CD4^+$ cells) are a type of white blood cell. $CD4^+$ cells are also known as "helper T cells" because they play an important part in directing the immune system to respond to infections.

CRRA: Constant Relative Risk Aversion.

Discount rate (DR): The (annual) rate at which future values are diminished to make them comparable to values in the present.

DU: Discount utility.

Expected utility hypothesis: The utility of an agent facing uncertainty is calculated by considering utility in each possible state and constructing a weighted average. The weights are the agent's estimate of the probability of each state. The expected utility is thus an expectation in terms of probability theory.

EV: Expected value.

FED: Front-End-Delay.

Hardest hit countries: Countries having HIV prevalence rates of at least 10%.

HD: Hyperbolic discounting.

HIV: Human Immunodeficiency Virus.

HIV anticipatory savings hypothesis: the positive relationship between HIV contamination risk and individual savings due to the fact that individuals who are aware of the HIV contraction risk consider the possible additional future costs caused by the illness when deciding how much to save.

HIV incidence: Percentage of a population that contracted HIV in a certain period.

HIV prevalence: Percentage of a certain population that is HIV infected.

House money effect: The premise that people are more willing to take risks with money they obtained easily or unexpectedly.

Morbidity: The presence of disease.

MPL: Multiple pricelist.

nFED: no Front-End-Delay.

NWU: North West University.

Prospect: A finite probability distribution over monetary outcomes.

Prudent: An agent is prudent if and only if the marginal utility of future consumption is convex.

PU: Pretoria University.

Risk Aversion (RA): Wanting to avoid risk unless adequately compensated for it.

Time discounting: Encompasses *any* reason for caring less about a future consequence including factors that diminish the expected utility generates by a future consequence such as uncertainty or changing tastes.

Time preference: Refers to specifically the preference for immediate utility over delayed utility. Time preference is the rate at which people are willing to trade current benefit (utility) for future benefit. Having low time preference means a person is patient and has good self-control, i.e., values the future. Having high time preference means a person much prefers satisfaction now (being impatient, lacks self-control), and greatly discounts the future.

Viral load: The actual number of viruses in the blood.

Visceral influences: Visceral factors temporarily increase agents' valuation of the proximate reward, which could bias the discount rate upward.

Worst hit countries: Countries having HIV prevalence rates of at least 20%.

Nederlandse Samenvatting

Na de ontdekking van AIDS in 1981, heeft de AIDS-epidemie zowel in omvang als impact alle verwachtingen overtroffen. Naar schatting leven er wereldwijd 39,5 miljoen mensen met HIV en zijn al ruim 25 miljoen mensen aan AIDS gerelateerde ziekten overleden (UNAIDS, 2006). Swaziland voert deze ogenschijnlijk onbegrensde wereldranglijst aan: meer dan een derde van de volwassen bevolking is inmiddels HIV besmet. Het staat onomstotelijk vast dat huishoudens die geconfronteerd worden met een geïnfecteerd familielid, te kampen hebben met de meest ernstige consequenties van de ziekte. Zij moeten naast de verschillende gezondheids- en psychische problemen zoals lichamelijke achteruitgang, zware veeleisende medicatie, verzorging van een AIDS-ziek familielid, stigmatisering, en groot verdriet bij verlies, ook vele economische problemen trotseren. De ziekte maakt volledig functioneren vaak onmogelijk en heeft op den duur arbeidsongeschiktheid tot gevolg. In ontwikkelingslanden waar een groot deel van de bevolking al in armoede leeft en er nauwelijks sprake is van een goed functionerend sociaal vangnet, betekent dit vaak een daling van het al schamele inkomen, terwijl tegelijkertijd de uitgaven door de hoge kosten aan medische zorg toenemen. Vanuit economisch oogpunt is het derhalve van belang om te onderzoeken hoe huishoudens met een geïnfecteerd familielid met deze situatie omgaan. Dwingt de situatie hen bijvoorbeeld juist om financiële maatregelen te nemen, zoals extra

sparen, *voordat* besmetting heeft plaatsgevonden en de verhoogde uitgaven en het verlaagd inkomen aan de orde zijn? Beter gezegd, passen huishoudens hun economisch gedrag aan om de economische gevolgen van HIV te kunnen beperken?

In de meeste getroffen gebieden, dragen niet alleen de direct met HIV geconfronteerde huishoudens het economische leed. De epidemie leidt daar ook tot een ontwrichting van de algehele samenleving. Bedrijven krijgen bijvoorbeeld te maken met veel verzuim, afname in de productiviteit van de lichamelijk en/of psychisch belaste arbeidskrachten en dus verminderde effectiviteit van investeringen. Overheden worden geconfronteerd met verhoogde uitgaven aan zorg en sociale zekerheid, terwijl tegelijkertijd de belastinggrondslag is aangetast. Onder deze omstandigheden kunnen huishoudens dus slechts op beperkte steun van de overheid rekenen. Bovendien is het te verwachten dat de economische groei zal stagneren, wat de mogelijkheden voor overheden om deze huishoudens te ondersteunen verder zal beperken. Macro-empirische studies die de impact van HIV op de economische groei bestuderen laten echter opmerkelijk uiteenlopende effecten, van negatief tot zelfs positief, zien. Deze bevindingen vragen om een verklaring. Empirisch onderzoek op microniveau zou inzicht kunnen geven in een antwoord op de volgende vragen. Berusten de bestaande studies op verschillende, waaronder ook onjuiste, aannames? Worden slechts bepaalde segmenten van de samenleving negatief beïnvloed, terwijl andere er juist beter van worden (zoals een van de paradoxen beschreven door Amartya Sen in zijn beroemde boek: "Poverty and famines"). Of vinden er aanpassingsmechanismen plaats op microniveau, die de verwachte negatieve invloed op de totale economie verkleinen?

Dit proefschrift heeft tot doel een bijdrage te leveren aan een antwoord op de laatste vraag: zorgen micro-economische processen of gedragsveranderingen ervoor dat de gevreesde impact van HIV op economische groei wordt beperkt? Zouden deze gedragingen gestimuleerd kunnen worden? Dit onderzoek spitst zich voornamelijk toe op de vraag hoe de AIDS epidemie de economische keuzen van gezinnen beïnvloedt over de tijd en bestudeert met name het spaargedrag. Zoals hierboven beschreven, zijn de economische consequenties voor gezinnen met een HIV-besmet familielid groot. In landen waar slechts weinigen medisch verzekerd zijn en velen in armoede leven is het belangrijk te analyseren welke specifieke financiële strategieën zij zouden kunnen aanwenden om een mogelijke schok als HIV/AIDS op te kunnen vangen. Door bijvoorbeeld extra te sparen kunnen huishoudens eerder een medische behandeling betalen, en als gevolg daarvan ook langer in het arbeidsproces blijven.

Dit heeft als bijeffect dat niet alleen huishoudens beter in staat zijn de economische klappen van een besmetting op te vangen, maar dat ook de economische groei minder wordt beperkt. Dit leidt tot de kernvraag van dit onderzoek: anticiperen mensen op de economische kosten die verbonden zijn aan een HIV-besmetting door extra te gaan sparen? Om deze kernvraag te beantwoorden, wordt in dit onderzoek gebruik gemaakt van zowel theoretische, empirische als experimentele methoden. De analyse spitst zich niet zoals vele bestaande micro-empirische studies toe op het economische gedrag van al met HIV geïnfecteerde individuen, maar juist ook op het gedrag van individuen die (nog) niet geïnfecteerd zijn. Immers, ook de gepercipieerde kans dat men in de toekomst geïnfecteerd kan raken met het virus kan het economische gedrag beïnvloeden. Tevens is onderzocht of deze percepties ook overeenkomen met het reële risico dat men loopt door de relatie ervan met het seksuele gedrag te bestuderen.

Als theoretische kader voor dit onderzoek is een tweeperiode levensloopmodel gebruikt dat gebaseerd is op de aanname dat individuen hun consumptie spreiden over hun gehele leven. HIV/AIDS beïnvloedt dit proces zowel direct als indirect. Er is sprake van directe beïnvloeding van dit proces door de negatieve invloed op het inkomen als gevolg van een afname in de productiviteit bij besmetting. Indirect wordt dit proces beïnvloed door de afname van de verwachte levensduur en de toename in de medische uitgaven die noodzakelijk zijn om de ziekte in toom te houden. Hoewel in de bestaande literatuur over HIV/AIDS en intertemporele keuzen wel inzicht wordt verschaft in de effecten van de verkorte levensduur (zoals Freire (2004)), is slechts weinig bekend over hoe de gepercipieerde kans op ziek worden en de daarmee gepaard gaande verwachte ziektekosten deze keuze beïnvloeden. Er bestaan relatief weinig studies over het spaargedrag van huishoudens in ontwikkelingslanden, terwijl juist aanpassen van het spaargedrag een van de mogelijkheden is voor huishoudens om zelfstandig inkomensschokken, zoals die veroorzaakt worden door een HIV-besmetting, deels het hoofd te kunnen bieden. (Natuurlijk is sparen slechts mogelijk bij een inkomen boven het bestaansminimum.) Sparen kan namelijk op verschillende manieren, zowel formeel als informeel. Sparen zou een uitkomst kunnen zijn in landen met een beperkte financiële of weinig toegankelijke ziektekostenverzekeringsmarkt.

Voor het empirische en experimentele kader is onderzoek gedaan onder studenten in Zuid-Afrika waarbij, naast individuele karakteristieken, het economische en het seksuele gedrag bestudeerd is. Deze gegevens zijn aangevuld met schattingen van de individuele risicohouding

en tijdsvoorkeuren op basis van economische experimenten. Bij het meten van de risicoaversie kreeg de respondent een lijst voorgelegd met tien keuzes tussen twee mogelijke loterijen. De ene loterij was riskanter dan de andere, waarbij de kans op uitbetaling van de prijs van de riskante loterij toenam over tien keuzes. Bij een zekere mate van risicoaversie zal de deelnemer, wanneer de verwachte opbrengst van de riskante loterij hoog genoeg is, op een gegeven moment voor de riskante loterij kiezen. Het precieze moment van overgang geeft een individuele maat voor risicoaversie. Bij het meten van de tijdsvoorkeuren wordt er eenzelfde soort methode toegepast. De respondent wordt gevraagd te kiezen tussen een bepaald bedrag te ontvangen in het heden of een hoger bedrag in de toekomst, bijvoorbeeld over een jaar. Op de lijst met bedragen waartussen ieder individu gevraagd wordt te kiezen neemt het bedrag dat men in de toekomst kan ontvangen telkens toe. Op een gegeven moment is dit bedrag zo hoog dat de respondent overgaat op de toekomstige uitbetaling. Het moment van overgang geeft derhalve een maat voor de tijdsvoorkeur van ieder individu. Een deel van de participanten werd daadwerkelijk betaald voor hun keuzen, om ervoor te zorgen dat de vragen naar waarheid werden ingevuld.

De resultaten van dit proefschrift laten zien dat de AIDS-epidemie het spaargedrag van zowel geïnfecteerde als niet-geïnfecteerde individuen beïnvloedt. Zo laat hoofdstuk 4 van dit onderzoek op basis van zowel theorie als empirische analyse zien dat de AIDS-epidemie het spaargedrag op de volgende twee tegengestelde manieren kan beïnvloeden: enerzijds verlaagt de toename in de kans op vervroegde sterfte het bedrag dat individuen sparen en anderzijds vergroot de kans op ziekte hun besparingen. Hoewel HIV de verwachte levensduur aanzienlijk verkort, blijkt uit de data het positieve effect van een verwachte hoge besmettingskans op de individuele besparingen te domineren. Dit blijkt ook te gelden voor reeds met HIV-geïnfecteerde individuen. Daarnaast blijken medisch verzekerde individuen met een hoge gepercipieerde besmettingskans ook meer te sparen, wat doet vermoeden dat individuen niet alleen op de medische kosten anticiperen maar ook bijvoorbeeld op de verwachte inkomensdaling. Deze resultaten suggereren dat in een maatschappij waarin de bevolking dagelijks wordt geconfronteerd met diverse aspecten van de AIDS-epidemie, individuen hun spaargedrag aanpassen door de onzekerheden die de epidemie met zich meebrengt, zoals vervroegde sterfte, ziektekosten en inkomensdaling. In dit proefschrift wordt het verschijnsel dat mensen anticiperen op een mogelijke HIV-besmetting door hun besparingen te verhogen, "het HIV-anticiperend spaarmotief" genoemd. Natuurlijk zullen

mensen hun besparingen pas vergroten als ze zich ook bewust zijn van zowel de kans op besmetting als de bijbehorende kosten.

Hoofdstuk 4 laat echter niet zien hoe de geaggregeerde besparingen in een land worden beïnvloed. Zoals gezegd vormt kennis over de besmettingskans en het algemene kostenplaatje van een HIV-besmetting de sleutel tot een stijging in de besparingen. Dit varieert niet alleen van individu tot individu, maar is ook gerelateerd aan het stadium waarin de epidemie zich bevindt. In een vroeg stadium, wanneer de ziekte nog relatief weinig voorkomt, zal het bewustzijn laag zijn en zullen de besparingen anders beïnvloed worden dan in het stadium waarin eenieder in de samenleving dagelijks met de ziekte of de consequenties ervan in aanraking komt. Hoofdstuk 5 bestudeert daarom hoe het verloop van de epidemie de besparingen beïnvloedt door in het theoretische tweeperiode levensloopmodel deze bewustwording te incorporeren en daarbij onderscheid te maken tussen mensen die wel en niet getest zijn op HIV. Het uitgebreide model voorspelt een niet-monotone relatie tussen de verschillende stadia van de AIDS-epidemie en de besparingen in een land. In het beginstadium van de epidemie, wanneer de ziekte nog nauwelijks bekend is, zullen seropositief geteste mensen, minder geneigd zijn te sparen omdat het nut om te sparen voor consumptie op latere leeftijd afneemt door de toegenomen sterftekans. In dit stadium zullen de totale besparingen in een land naar verwachting dalen. Dit is precies het negatieve effect dat Bonnel (2000) vond in zijn landenstudie gebruikmakend van data in de beginperiode van de epidemie. Maar als de bevolking zich in een latere fase van de epidemie bewust wordt van zowel de besmettingskans als de economische gevolgen van de ziekte, nemen de besparingen toe en kunnen die zelfs op een hoger niveau komen dan in de situatie zonder epidemie. Het bewustwordingsproces wordt in hoofdstuk 5 gemodelleerd door de testintensiteit. Deze testintensiteit staat voor het deel van de bevolking die getest wordt op HIV. Pas als deze frequentie hoog genoeg is en ook het nut van medische consumptie ten opzichte van reguliere consumptie groot genoeg is, zullen de besparingen in een land stijgen. Gezien de noodzaak van medicijngebruik is aan de tweede voorwaarde al snel voldaan. Omdat in dit model aangenomen wordt dat mensen met een HIV-besmetting vervroegd zullen overlijden, zullen zij hun inkomen over een kortere periode spreiden en relatief vroeg gaan ontsparen. Daarom zullen in een vergevorderd stadium van de epidemie, als er een relatief groot deel van de bevolking het virus draagt, de besparingen in een land weer gaan dalen.

Het negatieve effect op de besparingen in de eerste periode ontstaat door imperfecte informatie. Aangezien het model voorspelt dat de besparingen toenemen als de testintensiteit wordt verhoogd, zou dit een beleidsmiddel kunnen zijn om huishoudens te laten anticiperen op een mogelijke HIV-besmetting. Daarom is onderzocht of het vergroten van de testintensiteit zou leiden tot een totale welvaartsverhoging. Vergroting van de testintensiteit in een latere periode van het leven zal leiden tot een verhoging van de welvaart. Ook verhoging van de testintensiteit in een vroeg stadium van het leven zorgt ervoor dat individuen hun inkomen efficiënter kunnen inzetten. HIV-positief getesten hoeven niet meer onnodig te sparen voor consumptie op latere leeftijd. Aan de andere kant kan HIV-positief getest worden echter ook leiden tot negatieve andere dan economische gevolgen zoals psychische aspecten als de angst om dood te gaan, of stigmatisering. Als deze negatieve aspecten de overhand hebben, zou het verhogen van de testintensiteit de welvaart mogelijk negatief kunnen beïnvloeden. Omdat we in het model een verzekering voor het "risico" voor langleven postuleren waarin niet geparticipeerd kan worden door HIV-negatief geteste individuen, simpelweg omdat dan met zekerheid uitgekeerd zou worden, is het welvaartseffect van de verhoging van de testintensiteit in de vroege periode van het leven voor HIV-negatieven niet eenduidig vast te stellen. Alhoewel zij in de eerste periode geen onzekerheid kennen om vervroegd te overlijden en dus hun inkomen in de eerste periode van hun leven optimaal kunnen inzetten, is hun inkomen in de tweede periode relatief laag. Zij kunnen namelijk niet meeprofiteren van de uitkering van de "langlevendheid" verzekering. Ook hoofdstuk 5 laat zien dat mensen ontsparen bij een toegenomen sterftekans en extra sparen als de kans op HIV-besmetting in de toekomst groot is. Bovendien leidt testen in de meeste gevallen tot een welvaartsstijging.

De invloed van het individuele HIV-anticiperend spaarmotief op de totale besparingen in een land hangt naast de gepercipieerde besmettingskans ook af van de individuele risicohouding en tijdvoorkeuren. Deze laatste twee kunnen bovendien gerelateerd zijn aan het risico om met HIV besmet te raken. Risicomijdende mensen zullen eerder voorzorgsmaatregelen nemen dan risicozoekende mensen. Ook mensen die meer op de lange termijn georiënteerd zijn, zullen eerder anticiperen op de kosten van een ziekte die pas eventueel later aan de orde zijn. Risicohouding en tijdvoorkeuren beïnvloeden ook het seksuele gedrag, wat de relatie met de besparingen nog verder compliceert. Hoofdstuk 6 bestudeert deze relaties aan de hand van de experimentele data verzameld onder studenten in Zuid-Afrika.

De resultaten van de experimenten tonen aan dat deelnemers met seksuele ervaring beduidend meer risicozoekend gedrag vertonen dan deelnemers zonder die ervaring. Er is echter geen relatie tussen condoomgebruik en risicohouding gevonden. Als we geïsoleerd kijken naar de risicohouding van mensen, lijkt het hebben van seksuele contacten in een land met hoge besmettingspercentages op zichzelf een risicovolle onderneming. Risicomijdende personen lijken namelijk onthouding als alternatief te zien voor het gebruik van condooms om HIV-besmetting te voorkomen, terwijl de keuze om geen condoom te gebruiken niet afhangt van de individuele risicohouding.

Zoals gezegd brengt HIV-besmetting aanzienlijke kosten voor de toekomst met zich mee. Mensen met een hoge discontovoet, die meer op het heden georiënteerd zijn, wegen die kosten relatief minder zwaar. Het is dan ook te verwachten dat mensen met een hoge discontovoet eerder riskant seksueel verdrag vertonen dan mensen met een lage discontovoet. Uit hoofdstuk 6 blijkt inderdaad dat, na correctie voor onder andere socio-economische achtergrond en kennis van de ziekte, zowel mensen die seksuele contacten hebben als mensen die onveilig vrijen een significant hogere discontovoet hebben. Onveilig vrijen blijkt dus voor een deel een economische verklaarbare keuze behorende bij de individuele risicohouding en tijdvoorkeur. Dit betekent dat er in HIV-preventie naast kennis, ook aandacht dient te komen voor deze karakteristieken. Deelnemers die zich hadden laten testen en HIV-negatief waren bevonden bleken risicomijdender gedrag te vertonen. De uitslag van de test lijkt hun risicohouding te weerspiegelen. Deelnemers die aangaven nooit getest te zijn, vertoonden in het algemeen ook risicozoekender gedrag. De resultaten van dit onderzoek laten zien dat het faciliteren van testen op vrijwillige basis een onevenredig groot percentage (HIV-negatieve) risicomijders aantrekt. In campagnes om mensen te werven om zich vrijwillig te laten testen is het daarom aan te bevelen op risicozoekend gedrag in te spelen.

Zowel HIV-positieve deelnemers aan het experiment als deelnemers die de kans op een mogelijke HIV-besmetting groot achten, de zogenaamde "risicogroep", vertonen beduidend minder risicomijdend gedrag. Als we aannemen dat hun risicohouding ook vertaald wordt in hun seksueel gedrag, dan onderschrijft dit hun gedragingen. Deze risicogroep heeft karakteristieke risico- en tijdvoorkeuren die het HIV-anticiperend spaarmotief afremmen. Juist de groep die dus op een HIV-besmetting zou *moeten* anticiperen, zal dit verhoudingsgewijs in mindere mate doen. Hoewel de risicogroep meer op het nu georiënteerd is, blijken HIV-positief geteste deelnemers juist toekomstgericht te zijn, de geschatte

tijdvoorkeur is significant lager. Dit is om twee redenen een opmerkelijk resultaat: ten eerste blijkt uit het onderzoek dat tijdvoorkeur in verband staat met seksueel gedrag. Daarnaast is de levensduur aanzienlijk korter, wat juist het "carpe diem" gedrag zou kunnen stimuleren. Alhoewel we geen gegevens hebben over meerdere perioden en dus niets kunnen zeggen over gedragsveranderingen, suggereren deze resultaten dat tijdvoorkeuren veranderen na besmet te zijn geraakt met HIV.

Dit opvallende resultaat uit hoofdstuk 6 wordt verder onderzocht in hoofdstuk 7. De impliciete aanname dat slechts tijdvoorkeuren de waardering van toekomstige baten bepaalt wordt losgelaten en tijdvoorkeuren worden opnieuw geschat met correcties voor verschillen in verwachtte levensduur en risicohouding. Na deze correcties, die de geschatte tijdvoorkeuren van de andere groepen verhoudingsgewijs substantieel verlagen, vertonen HIV-positieven nog steeds een significant lagere tijdvoorkeur ten opzichte van de risicogroep. Uit de data blijkt dat HIV-positieve studenten met een medische verzekering echter wel een veel hogere tijdvoorkeur vertonen. Dit wordt verklaard door het feit dat de gemeten individuele tijdvoorkeur ook de perceptie over het toekomstige consumptieniveau bevat. Uit de experimentele data is de verwachte daling in het consumptieniveau over 2 jaar voor HIV-positieven berekend welke uitkomt op 66% van het huidige consumptieniveau. Dit komt overeen met de daling die Steinberg et al. (2000) hebben gemeten in een empirisch onderzoek onder HIV-huishoudens in Zuid-Afrika. Het anticiperende gedrag van de HIV positieve groep komt dus niet alleen tot uiting in het totale bedrag dat zij sparen maar ook in de gemeten discontovoet van degenen die niet verzekerd zijn. Blijkbaar sparen ze niet voldoende om de verwachte consumptiedaling op te vangen en grepen ze de experimenten aan als een mogelijkheid om hun besparingen aan te vullen. Alhoewel de niet-verzekerde HIV positieve groep rekening blijkt te houden met een daling van het toekomstige consumptieniveau in de waardering van toekomstige baten, lijkt de risicogroep dit echter niet te doen. Wel houden zij rekening met een kortere levensduur. Na toepassing van de laatste correctie blijken HIV-positieve deelnemers geen significant lagere tijdvoorkeur te hebben ten opzichte van de risicogroep. De gecorrigeerde schattingen laten nu wel een duidelijk positief verband tussen de verwachte besmettingskans en tijdvoorkeur zien. Een HIV besmetting verandert dus de waardering van toekomstige baten, ofwel de discontovoet, maar niet de individuele tijdvoorkeur. Omdat seksueel gedrag gerelateerd is aan risico- en tijdvoorkeuren, zou preventie gericht op risico- en tijdvoorkeurverandering bij kunnen dragen aan de beperking van een verdere verspreiding van het virus. Dit is geenszins eenvoudig aangezien risico- en

tijdvoorkeuren met name in de eerste levensjaren worden ontwikkeld, en bovendien is dit vanuit ethisch oogpunt wellicht ook niet wenselijk. Echter preventie gericht op het vergroten van informatie over de totale verwachte kosten van risicovol seksueel gedrag, zou de keuze voor dit gedrag ook al kunnen beperken. Men kan hierbij denken aan zowel het informeren over de actuele besmettingskans als de kosten van een besmetting, zodat mensen op basis van hun eigen risico- en tijdvoorkeuren een voor hen optimale beslissing kunnen nemen. Gegeven de hoge tijdvoorkeur van de risicogroep kunnen ook monetaire prikkels zoals gratis condooms ervoor zorgen dat de keuze voor risicovol seksueel gedrag wordt beperkt.

Al met al, blijkt dat mensen die zich bewust zijn van de AIDS-epidemie, zowel de vervroegde sterftekans als de toename in de verwachte ziektekosten meenemen in hun spaargedrag. Binnen de onderzochte groep leidt dit per saldo toch tot een toename van de individuele besparingen. Deze toename vergroot de mogelijkheden voor gezinnen om de financiële consequenties van een HIV-besmetting het hoofd te kunnen bieden. Sparen vergroot niet alleen de toegang tot medische behandeling maar verlengt de productieve periode zodat de negatieve impact op de economische groei hierdoor wordt verkleind. Mensen die zich niet voldoende bewust zijn van de besmettingskans en de bijbehorende kosten zullen onvoldoende anticiperen op de economische consequenties. Deze mensen moeten dus bewust worden gemaakt van de risico's die ze lopen. Hiervoor zijn 2 mogelijkheden: Het vergroten van de testintensiteit, waarbij wel moet worden toegezien op de beperking van de externe effecten zoals de stigmatisering van HIV-positieve individuen. Daarnaast, preventiecampagnes waarin naast op het bestaan van AIDS en de preventiemogelijkheden, sterk de nadruk wordt gelegd op het feitelijke besmettingspercentage en de financiële consequenties van een HIV besmetting.

Ook blijkt riskant seksueel gedrag een economische keuze te zijn die afhangt van de individuele risicohouding en tijdvoorkeur. Juist de risicohouding en tijdvoorkeuren, die horen bij riskant seksueel gedrag beïnvloeden het HIV-anticiperend spaarmotief negatief. Hier zien we dat de mensen die eigenlijk zouden moeten sparen het te weinig doen. In HIV-preventie is het daarom van belang, om naast het vergroten van de testintensiteit en het vergroten van de kennis van de feitelijke besmettingskans, ook aandacht te hebben voor het veranderen van de risicohouding en tijdvoorkeur van mensen. Dit laatste vergt echter een compleet andere invalshoek dan de huidige, is geenszins eenvoudig en op individueel niveau wellicht onethisch en dus niet wenselijk. Het veranderen van de risicohouding en de tijdvoorkeur zou echter

twee positieve effecten kunnen hebben. Het zou niet alleen het riskante seksuele gedrag kunnen beperken, wat een verdere verspreiding van het virus tegengaat. Daarnaast kan hierdoor het "HIV-anticiperend spaarmotief" worden gestimuleerd, zodat mensen die het virus alsnog oplopen beter in staat zijn met de economische consequenties om te gaan. Discussie over de ontwikkeling van preventie gericht op het beïnvloeden van deze karakteristieken is daarom op basis van de resultaten van dit onderzoek sterk aan te bevelen.